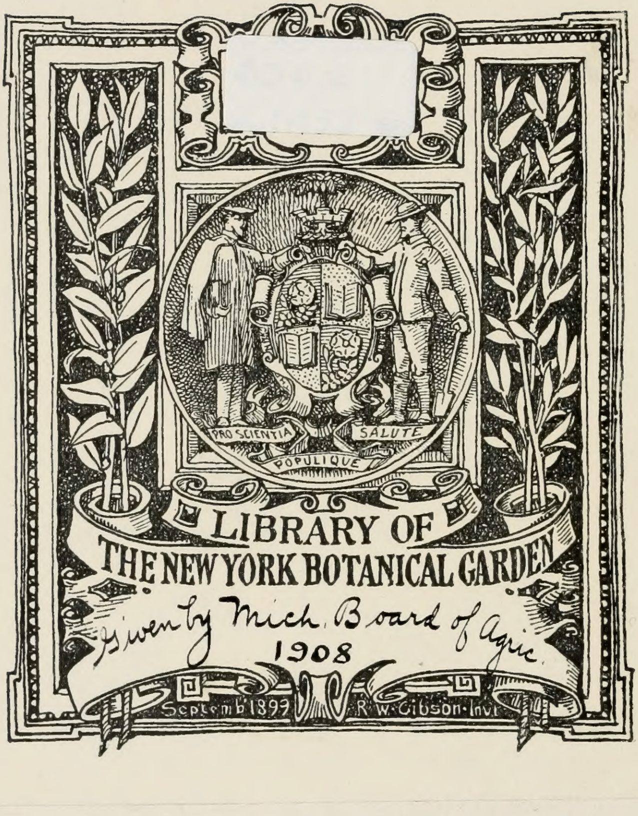
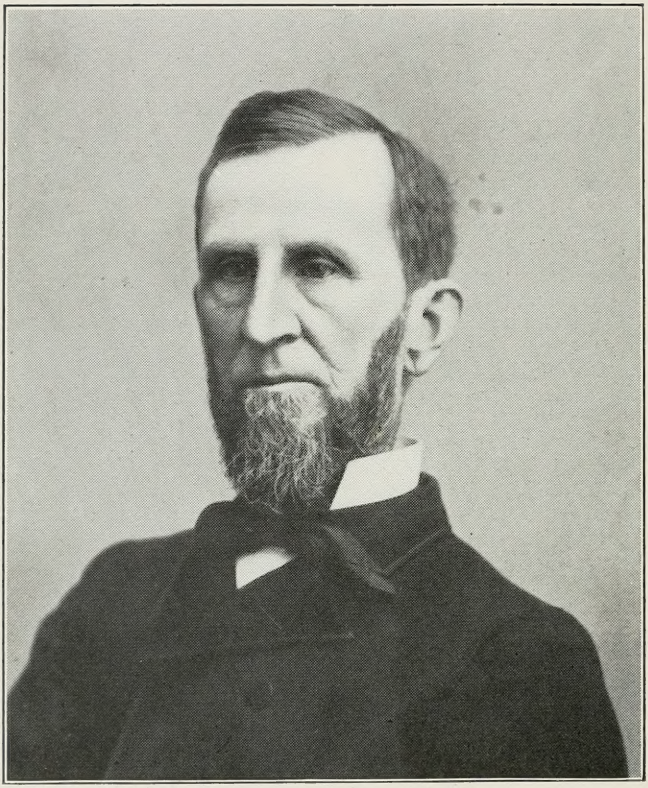

PRO SCIENTIA
SALUTE
POPULIQUE
LIBRARY OF
THE NEW YORK BOTANICAL GARDEN
Given by Mich. Board of Agric.
1908
Septemb 1899
R. W. Gibson Invt



FRANKLIN WELLS.

For thirty years a member of the State Board of Agriculture.

FORTY-THIRD ANNUAL REPORT

OF THE

SECRETARY

OF THE

STATE BOARD OF AGRICULTURE

OF THE

STATE OF MICHIGAN

AND

SEVENTEENTH ANNUAL REPORT

OF THE

EXPERIMENT STATION

FROM

JULY 1, 1903, TO JUNE 30, 1904

BY AUTHORITY

LANSING, MICHIGAN
WYNKOOP HALLENBECK CRAWFORD CO., STATE PRINTERS
1904

REPORT OF THE SECRETARY

OF THE

STATE BOARD OF AGRICULTURE

AGRICULTURAL COLLEGE, *July 1, 1904.*

TO HONORABLE AARON T. BLISS,

Governor of the State of Michigan:

SIR—I have the honor to submit to you herewith, as required by law, the accompanying report for the fiscal year ending June 30, 1904, with supplementary papers.

Very respectfully,

ADDISON M. BROWN,

Secretary of the State Board of Agriculture.

Nov. 12, 1908.

STATE BOARD OF AGRICULTURE

	Term expires
CHARLES J. MONROE, South Haven, President of the Board.	1907
ROBERT D. GRAHAM, Grand Rapids,	1905
L. WHITNEY WATKINS, Manchester,	1905
CHARLES F. MOORE, St Clair,	1907
AARON P. BLISS, Saginaw,	1909
WILLIAM H. WALLACE, Bayport,	1909
AARON T. BLISS, Governor of the State,	*Ex-Officio.*
JONATHAN L. SNYDER, Pres. of the College,	*Ex-Officio.*

A. M. BROWN, Agricultural College, Secretary.
B. F. DAVIS, Lansing, Treasurer.

STANDING COMMITTEES.

The President of the Board is *ex-officio* a member of each of the Standing Committees.

Botany and Horticulture,	R. D. Graham, C. F. Moore.
Buildings and College Property,	A. P. Bliss, R. D. Graham.
Chemical, Physical, Bacteriological and other departments not otherwise provided for	A. P. Bliss, L. W. Watkins.
Employees,	R. D. Graham, C. F. Moore, J. L. Snyder.
English and Mathematics,	W. H. Wallace, A. P. Bliss.
Experiment Station,	C. F. Moore, L. W. Watkins.
Farm Management,	L. W. Watkins, R. D. Graham.
Finance,	R. D. Graham, A. P. Bliss.
Forestry,	A. P. Bliss, C. F. Moore.
Farmers' Institutes,	C. F. Moore, R. D. Graham.
Land Grant,	L. W. Watkins, W. H. Wallace.
Library,	C. F. Moore, A. P. Bliss.
Mechanical Department,	W. H. Wallace, C. F. Moore.
Military and Athletics,	L. W. Watkins, W. H. Wallace.

STATE AGRICULTURAL COLLEGE

(Under control of the State Board of Agriculture.)

FACULTY AND OTHER OFFICERS.

JONATHAN L. SNYDER, A. M., Ph. D., President; [a] [b] [c] Feb. 25, '96.

WM. J. BEAL, A. M., M. S., Ph. D., Professor of Botany and Curator of the Botanical Museum; [a] [b] July 9, '70; [c] Sept. 1, '02.

FRANK S. KEDZIE, M. S., Professor of Chemistry; [a] Sept. 15, '80; [b] [c] Sept. 1, '02.

WILLIAM S. HOLDSWORTH, M. S., Professor of Drawing; [a] Feb. 22, '81; [b] Aug. 22, '87; [c] Sept. 1, '03.

LEVI R. TAFT, M. S., Superintendent of Farmers' Institutes and State Inspector of Orchards and Nurseries; [a] Aug. 1, '88; [b] [c] July 1, '02.

HOWARD EDWARDS, A. M., LL. D., Professor of English Literature and Modern Languages; [a] [b] [c] Aug. 25, '90.

HERMAN K. VEDDER, C. E., Professor of Mathematics and Civil Engineering; [a] [b] [c] Sept. 15, '91.

CLINTON D. SMITH, M. S., Dean of Short Courses, College Extension Lecturer; [a] [b] Sept. 1, '93; [c] July 1, '02.

CHARLES L. WEIL, B. S., Professor of Mechanical Engineering and Director of the Mechanical Department; [a] [b] [c] Sept. 1, '93.

WALTER B. BARROWS, B. S., Professor of Zoology and Physiology and Curator of the General Museum; [a] [b] [c] Feb. 15, '94.

GEORGE A. WATERMAN, B. S., M. D. C., Professor of Veterinary Science; [a] [b] [c] Sept. 1, '98.

CHARLES E. MARSHALL, Ph. D., Professor of Bacteriology and Hygiene; [a] Sept. 1, '98; [b] [c] Sept. 1, '02.

ULYSSES P. HEDRICK, M. S., Professer of Horticulture and Landscape Gardening and Superintendent of Grounds; [a] Sept. 1, '99; [b] [c] July 1, '02.

JOSEPH A. JEFFERY, B. S. A., Professor of Agronomy and Soil Physics; [a] Sept. 1, '99; [b] [c] Nov. 11, '02.

*MAJOR CHARLES A. VERNOU, U. S. A., Professor of Military Science and Tactics; [a] [b] [c] Oct. 6, '00.

MAUD GILCHRIST, B. S., Dean of the Women's Department; [a] [b] [c] Sept. 1, '01.

ADDISON M. BROWN, A. B., Secretary; [a] [b] [c] June 1, '02.

ROBERT S. SHAW, B. S. A., Professor of Agriculture and Superintendent of Farm; [a] [b] [c] Sept. 1, '02.
ERNEST E. BOGUE, M. S., A. M., Professor of Forestry, [a] [b] [c] Sept. 1, '02.
MAJOR WILLIAM H. KELL, U. S. A., Professor of Military Science and Tactics; [a] [b] [c] Feb. 24, '04.
ARTHUR R. SAWYER, E. E., Professor of Physics and Electrical Engineering; [a] [b] [c] April 11, '04.
WILBUR O. HEDRICK, M. S., Assistant Professor of History and Political Economy; [a] [b] Aug. 24, '91; [c] Sept. 1, '93.
WARREN BABCOCK, B. S., Assistant Professor of Mathematics; [a] [b] June 30, '91; [c] Sept. 1, '93.
**MARTIN D. ATKINS, A. B., Assistant Professor of Physics and Electrical Engineering; [a] [b] [c] Sept. 1, '99.
E. SYLVESTER KING, Assistant Professor of English; [a] Jan. 1, '00; [b] [c] Sept 1, '02.
HERMAN W. REYNOLDS, B. S. in M. E., Assistant Professor of Mechanical Engineering; [a] Sept. 1, '00; [b] [c] Sept. 1, '02.
JAMES B. DANDENO, A. M., Ph. D., Assistant Professor of Botany; [a] [b] [c] Sept. 1, '02.

The names of instructors whose resignations took effect between June 30 and Sept. 1, '03, do not appear below.

THOMAS GUNSON, Instructor in Floriculture and Foreman of Greenhouse; [a] [b] April 1, '91; [c] March 1, '01.
MRS. LINDA E. LANDON, Librarian; [a] [b] [c] Aug. 24, '91.
BURTON O. LONGYEAR, B. S., Instructor in Botany; [a] [b] [c] Feb. 15, '94.
W. S. LEONARD, Instructor in Mechanical Engineering; [a] [b] [c] Sept 1, '96.
RUFUS H. PETTIT, B. S. A., Instructor in Zoology; [a] [b] [c] Feb. 1, '97.
††MRS. JENNIE L. K. HANER, Instructor in Domestic Art; [a] [b] [c] Sept. 1, '97.
CHACE NEWMAN, Instructor in Mechanical Drawing; [a] [b] Sept. 1, '97; [c] July 23, '01.
E. C. BAKER, Foreman of Foundry; [a] [b] [c] Nov. 1, '97.
CAROLINE L. HOLT, Instructor in Drawing; [a] [b] [c] Sept. 1, '98.
BERTHA M. WELLMAN, B. S., B. Pd., Instructor in English; [a] [b] [c] Sept. 1, '00.
S. FRED EDWARDS, M. S., Instructor in Bacteriology and Hygiene; [a] [b] [c] Sept. 1, '00.
CARRIE A. LYFORD, B. L., Instructor in Domestic Science; [a] Sept. 1, '00; [b] [c] Sept. 1, '02.
SARAH B. S. AVERY, Instructor in Physical Culture; [a] [b] [c] Sept. 1, '00.
JOHN MICHELS, B. S. A., Instructor in Dairying; [a] [b] [c] Sept. 1, '00.
JESSE J. MYERS, B. S., Instructor in Zoology; [a] [b] [c] Sept. 1, '01.
†H. K. PATRIARCHE, B. S., Assistant Librarian; [a] [b] [c] Sept. 1, '02.
LEROY F. HARZA, B. S., Instructor in Mathematics; [a] [b] [c] Sept. 1, '02.
JENNETTE C. CARPENTER, B. S., Instructor in Cookery; [a] [b] [c] Sept. 1, '02.
LOUISE FREYHOFER, B. S., Instructor in Music; [a] [b] [c] Sept. 1, '02.
MRS. MAE GINGLES, Instructor in Sewing; [a] [b] [c] Sept. 1, '02.
L. W. SAWTELLE, B. S., Ph B., Instructor in English; [a] [b] [c] Sept. 1, '02.
L. G. HOLBROOK, Ph. B., Instructor in Physics; [a] [b] [c] Sept. 1, '02.
HARRY S. REED, Instructor in Chemistry; [a] [b] [c] Sept. 1, '02.

Andrew Krentel, Foreman Wood Shop; [a b c] Sept. 1, '02.
H. W. Norton, Jr., B. S., Instructor in Animal Husbandry; [a b c] Sept. 1, '03.
‡O. O. Churchill, B. S., Instructor in Agriculture; [a b c] Sept. 1, '03.
Ray R. Tower, B. S., Instructor in Chemistry; [a b c] Sept. 1, '03.
Otis M. Riggs, Instructor in Chemistry; [a b c] Sept. 1, '03.
Perry H. Edmonds, Instructor in Chemistry; [a b c] Sept. 1, '03.
Richard Hopkins, B. S. in C. E., Instructor in Civil Engineering; [a b c] Sept. 1, '03.
George W. Hartwell, Ph. B., Instructor in Mathematics; [a b c] Sept. 1, '03.
William J. Carrel, B. S., Instructor in Mathematics; [a b c] Sept. 1, '03.
Ward R. Shedd, B. S., Instructor in Mechanical Engineering; [a b c] Sept. 1, '03.
George Tryon, B. S., Instructor in Mechanical Engineering; [a b c] Sept. 1, '03.
Harvey L. Curtis, A. M., Instructor in Physics; [a b c] Sept. 1, '03.
Helen E. St. John, Instructor in Sewing; [a b c] Sept. 1, '03.
Chester L. Brewer, B. S., Director of Physical Culture; [a b c] Sept. 1, '03.
Albert E. Jones, A. B., Instructor in Mathematics; [a b c] Sept. 15, '03.
C. A. McCue, B. S., Instructor in Horticulture; [a b c] Oct. 1, '03.
¶H. J. Eustace, B. S., Instructor in Horticulture; [a b c] Jan. 1, '04.
Leslie B. McWethy, B. S., Instructor in Agriculture; [a b c] June 1, '04.
Paul Theodore, Foreman of Forge Shop.
Fred C. Kenney, Cashier; [a b] Sept. 18, '95; [c] Oct. 1, '97.
Lena M. Maxwell, Bookkeeper; [a b c] July 1, '02.
S. Alice Earl, Clerk to Secretary; [a b c] Oct. 1, '02.
Elida Yakeley, Secretary to President; [a b c] July 15, '03.
L. F. Newell, Engineer; [a b c] Jan. 1, '98.
E. A. Bowd, Architect; [a b c] Jan. 1, '02.
Rowena Ketcham, in charge of College Hospital; [a b c] Sept. 1, '00.
Gerrit Masselink, B. S., Editor M. A. C. Record; [a b c] Sept. 1, '03.
Caroline Balbach, Assistant Librarian; [a b c] Jan. 1, '04.

---

a First Appointment.
b Present Appointment.
c Present Title.
* Resigned, February, 23, '04.
** Resigned, September 30, '03.
† Resigned, October 15, '03.
‡ Resigned, May 31, '04.
¶ Resigned, February 6, '04.
†† Absent on leave.

AGRICULTURAL EXPERIMENT STATION

OF THE

MICHIGAN AGRICULTURAL COLLEGE.

(Under the control of the State Board of Agriculture.)

STATION COUNCIL.

J. L. Snyder, M. A., Ph. D., Pres., *Ex-officio* Member.
Clinton D. Smith, M. S., Director.
L. R. Taft, M. S., Horticulturist.
R. H. Pettit, B. S. A., Consulting Entomologist.
F. W. Robison, B. S., - Chemist.
Chas. E. Marshall, Ph. D., Bacteriologist and Hygienist.
R. S. Shaw, B. S. A., Experimenter with Live Stock.
A. M. Brown, A. B., Sec. and Treas.

ADVISORY AND ASSISTANT STAFF.

*M. L. Dean, - Asst. in Horticulture.
F. S. Kedzie, M. S., Associate Chemist.
Geo. A. Waterman, V. S., M. D. C., Consulting Veterinarian.
B. O. Longyear, B. S., Acting Consulting Botanist.
Mrs. L. E. Landon, - Librarian.
S. Fred Edwards, M. S., Asst. in Bacteriology and Hygiene.
T. A. Farrand, - In charge of South Haven sub-station.
Leo. M. Geismar, Chatham, in charge of Upper Peninsula Experiment Station.

SUB-STATIONS.

Grayling, Crawford county, 80 acres deeded.
South Haven, Van Buren county, 10 acres rented; 5 acres deeded. Local Agent, T. A. Farrand.
Chatham, Alger county, 160 acres deeded. Local Agent, Leo M. Geismar.

STANDING COMMITTEE IN CHARGE.

Hon. Charles F. Moore, - - - - - - - - - - - St. Clair.
Hon. L. Whitney Watkins, - - - - - - - - Manchester.

STATE WEATHER SERVICE.

(Under the control of the State Board of Agriculture.)

OFFICERS OF THE SERVICE.

Director, - - - - - - - C. F. Schneider, U. S. Weather Service.

* Resigned Sept. 30, '04.

ACCOUNTS OF THE STATE AGRICULTURAL COLLEGE.

FOR THE YEAR ENDING JUNE 30, 1904.

SECRETARY'S FINANCIAL REPORT.

			Dr.	Cr.
July 1, 1903.	To cash on hand		$3,668 46	
July 1, 1903.	To cash on deposit, college treasurer		6,025 74	
June 30, 1904.	To special appropriation receipts:			
	From State Treasurer	$21,000 00		
	From United States Treasurer	15,000 00		
	From institution and other sources	5,880 22		
			41,880 22	
June 30, 1904.	By special appropriation disbursements			$45,335 68
June 30, 1904.	To current account receipts:			
	From State Treasurer, land grant interest	$65,000 00		
	One-tenth mill tax	62,000 00		
	From United States Treasurer	25,000 00		
	From institution and other sources	45,375 58		
	From South Haven Experiment Station	831 24		
	From Upper Peninsula Experiment Station	290 78		
	From Farmers' Institutes	89 55		
			198,587 15	
	By general account disbursements:			
	Current account	$177,754 61		
	Supplementary accounts	18,742 32		
				196,496 93
	By cash on deposit, college treasurer			7,165 96
	By cash on hand			1,163 00
			$250,161 57	$250,161 57

TABLE No. 1.—*Tabular exhibit of secretary's report.*

	Balance sheet, July 1, 1903.		Transactions, July 1, 1903, to June 30, 1904.		Balance sheet, June 30, 1904.	
	Dr.	Cr.	Dr.	Cr.	Dr.	Cr.
Cash	$3,668 46	....	$2,505 46	....	$1,163 00	....
College treasurer*	6,025 74	....	....	$1,140 22	7,165 96	....
Special appropriations	....	$8,873 72	41,880 22	45,335 68	....	$5,418 26
Current accounts	....	820 48	197,375 58	177,754 61	....	2,910 70
Supplementary accounts	....	....	1,211 57	18,742 32	....	....
Totals	$9,694 20	$9,694 20	$242,972 83	$242,972 83	$8,328 96	$8,328 96

*Treasurer's statement is greater July 1, 1903, by $6,550.77, and June 30, 1904, by $13,143.03 warrants outstanding.

TREASURER'S ACCOUNT.

	Dr.	Cr.
Balance on hand July 1, 1903	$12,576 51	
Receipts from State Treasurer and secretary	242,846 48	
Interest on deposits, 12 months at 2½ per cent	285 79	
Warrants paid July 1, 1903, to June 30, 1904	....	$235,399 79
Balance on hand June 30, 1904	....	20,308 99
Total	$255,708 78	$255,708 78

TABLE NO. 2.—*Statement of special appropriation account for fiscal year, July 1, 1903, to June 30, 1904.*

Name of appropriation.	Balance of accounts July 1, 1903. Dr.	Balance of accounts July 1, 1903. Cr.	Receipts during fiscal year. From State treasury.	Receipts during fiscal year. From institution and other sources.	Total available.	Total expended.	Balance of accounts, June 30, 1904. Dr.	Balance of accounts, June 30, 1904. Cr.
Experiment Station	....	$81 07	*$15,000 00	$4,766 28	$19,847 35	$18,399 19	....	$1,448 16
Nursery License and Inspection	....	201 25	....	1,053 00	1,254 25	1,254 25	....	....
Power Plant	....	998 40	....	....	998 40	330 69	....	667 71
Bath House	....	3,335 87	....	....	3,335 87	2,218 55	†	....
Water System	....	4,258 31	4,000 00	....	8,258 31	6,722 84	††	....
Tunnels	....	....	10,000 00	....	10,000 00	13,802 73	$3,802 73	....
Sundry Improvements	....	....	1,000 00	....	1,000 00	941 08	....	2,711 71
Power House	....	....	5,000 00	....	5,000 00	594 59	....	4,405 41
Weather Service	$1 18	....	1,000 00	60 94	1,059 76	1,071 76	12 00	....
Balance	8,873 72	....	....	....	....	....	5,418 26	....
Total	$8,874 90	$8,874 90	$36,000 00	$5,880 22	$50,753 94	$45,335 68	$9,232 99	$9,232 99

* From United States Treasury.
† This unexpended balance of $1,117 32 transferred to Sundry Improvements.
†† This unexpended balance of $1,535 47 transferred to Sundry Improvements.

TABLE No. 3.—*Current account, July 1, 1903, to June 30, 1904.*

On account of—	Dr. To disbursements.	Cr. By receipts.
U. S. Treasurer, fifteenth annual payment under act of congress of August 30, 1890	....	$25,000 00
State Treasurer, one-tenth mill tax	....	62,000 00
State treasurer, interest on proceeds of sales of U. S. land grant	....	65,000 00
Salaries	$68,337 92	735 00
Farm department	12,583 51	6,065 42
Horticultural department	6,730 51	3,600 73
Mechanical department	7,736 81	1,631 79
Heating department	18,000 15	418 28
Cleaning department	1,982 97	132 94
Electric lighting department	7,995 13	2,073 49
Office	1,913 84	106 18
Advertising	1,844 31	....
M. A. C. Record	1,019 12	494 60
Special courses	2,960 27	863 47
Academic departments	14,915 22	5,649 38
Contingent building	27,001 00	19,946 21
Miscellaneous	1,594 00	2,161 42
Women's	3,139 85	1,496 67
Total	$177,754 61	$197,375 58
Supplementary amounts:		
Bulletins	3,651 99	....
Farmers' institutes	8,555 41	89 55
South Haven experiment station	2,132 06	831 24
Upper Peninsula experiment station	4,402 86	290 78
Balance at beginning of period, July 1, 1903	....	820 48
Balance at close of period, June 30, 1904	2,910 70	....
Total	$199,407 63	$199,407 63

TABLE No. 4.—*Experiment station account, July 1, 1903, to June 30, 1904.*

On account of—	Dr. To disbursements.	Cr. By receipts.
Balance from fiscal year, July 1, 1903	....	$81 07
U. S. Treasurer for fiscal year	....	15,000 00
Fertilizer license fees	....	2,140 00
Salaries	$7,390 72	....
Farm department	3,606 94	2,376 73
Horticultural department	404 48	....
Chemical department	1,874 13	....
Botanical department	185 04	....
Entomological department	454 64	8 50
Library	159 32	....
Sundry	30 00	11 05
Secretary's office	737 31	230 00
Veterinary	68 15	....
Live Stock	1,750 69	....
Bacteriological department	1,536 92	....
Director's office	200 85	....
Balance on hand June 30, 1904, close of fiscal year	1,448 16	....
Total	$19,847 35	$19,847 35

TABLE No. 5.—*Regular employes and salaries.**

Grade.	Rate per year.	Classification.		Other sources.	
		Current.	Experim't station.		
President's Office.					
President	$5,000 00	$5,000 00			Dwelling.
Secretary	500 00	500 00			
Agricultural Department.					
Professor	2,400 00	2,000 00	$400 00		
Prof. of Agronomy	2,000 00	2,000 00			
Inst'r Animal Husbandry	600 00	600 00			
" Dairying	950 00	950 00			
" Agriculture	550 00	550 00			
Foreman of College Farm	600 00	600 00			Dwelling.
Clerk Farm Dept	480 00	480 00			
Bacteriological Dept.					
Professor	2,000 00	1,000 00	1,000 00		
Instructor	750 00	600 00	150 00		
Botanical Dept.					
Professor	1,800 00	1,800 00			Dwelling.
Asst. Professor	1,150 00	1,150 00			
Instructor	800 00	700 00	100 00		
Chemical Dept.					
Professor	2,000 00	1,700 00	300 00		
Instructor	750 00	750 00			
"	550 00	550 00			
"	550 00	550 00			
"	550 00	550 00			
Chemist Experiment Station	1,000 00		1,000 00		Rooms.
Drawing Dept.					
Professor	1,800 00	1,800 00			
Instructor	700 00	700 00			
Inst'r Mech. Drawing	900 00	900 00			
English Dept.					
Professor	1,800 00	1,800 00			Dwelling.
Asst. Professor	1,000 00	1,000 00			Rooms.
Instructor	750 00	750 00			
"	600 00	600 00			
Forestry Dept.					
Professor	1,500 00	1,500 00			
Horticultural Dept.					
Professor	2,000 00	2,000 00			
Instructor	1,000 00	1,000 00			Dwelling.
Asst. Gardener	800 00	400 00	400 00		
Foreman of Grounds	500 00	500 00			Dwelling.
History and Pol. Economy Dept					
Asst. Professor	1,200 00	1,200 00			Rooms.
Institutes and Nursery Inspector.					
Superintendent	1,800 00	500 00	600 00	700 00	Dwelling.
Library Dept.					
Librarian	1,000 00	880 00	120 00		Rooms.
Asst. Librarian	350 00	350 00			
Mathematical Dept.					
Professor	1,800 00	1,800 00			Dwelling.
Asst. Professor	1,250 00	1,250 00			Rooms.
Inst'r Civil Engineering	750 00	750 00			
" Mathematics	550 00	550 00			
" "	600 00	600 00			
" "	500 00	500 00			
" "	550 00	550 00			

*With exception of President's arranged alphabetically according to Department.

TABLE No. 5.—*Concluded.*

Grade.	Rate per year.	Classification. Current.	Classification. Experim't station.	Other sources.	
Mechanical Dept..					
Professor	$1,800 00	$1,800 00	....	....	Dwelling.
Asst. Professor	1,400 00	1,400 00	....	....	....
Instructor	750 00	750 00	....	....	....
"	600 00	600 00	....	....	....
Foreman Machine Shop	1,000 00	1,000 00	....	....	....
Foreman Wood Shop	700 00	700 00	....	....	....
Foreman Foundry	750 00	750 00	....	....	....
Clerk	480 00	480 00	....	....	....
Military Dept.					
*Professor	576 00	576 00	....	....	....
Miscellaneous.					
Architect	1,500 00	1,500 00	....	....	....
Engineer	1,150 00	1,150 00	....	....	....
Plumber	900 00	900 00	....	....	....
Night Watchman	480 00	480 00	....	....	....
Editor M. A. C. Record and Clerk to President	1,000 00	1,000 00	....	....	....
Dean Short Courses and Director Experiment Station	2,000 00	400 00	$1,600 00	....	Dwelling.
Dept. of Physics.					
Professor	2,000 00	2,000 00	....	....	....
Instructor	600 00	600 00	....	....	....
"	700 00	700 00	....	....	....
Dept. of Physical Culture.					
Director	1,200 00	1,200 00	....	....	....
Secretary's Office.					
Secretary	1,800 00	300 00	500 00	1,000 00	Dwelling.
Cashier	1,200 00	1,000 00	200 00	....	....
Bookkeeper	600 00	500 00	100 00	....	....
Clerk	500 00	375 00	125 00	....	....
Veterinary Dept.					
Professor	1,500 00	1,200 00	300 00	....	....
Women's Dept.					
Dean	1,400 00	1,400 00	....	....	Rooms.
Inst'r Sewing	500 00	500 00	....	....	Room.
" Domestic Science	800 00	800 00	....	....	"
" Physical Culture	550 00	550 00	....	....	"
" Music	800 00	800 00	....	....	....
" Cookery	600 00	600 00	....	....	Room.
" Sewing	350 00	350 00	....	....	"
Nurse in charge College Hospital	450 00	450 00	....	....	Dwelling.
Zoological Dept.					
Professor	1,800 00	1,800 00	....	....	Dwelling.
Instructor	1,100 00	500 00	600 00	....	"
"	700 00	700 00	....	....	....
Total	$82,916 00	$73,721 00	$7,495 00	$1,700 00	....

*In lieu of quarters. Salary paid by U. S. Government.

TABLE No. 6.—*Income of the State Agricultural College from all outside sources from the date of its foundation to the present time.*

Year.	From State Legislature.			From U. S. Congress.			Total.
	For current expenses.	For special purposes.	Land sales, salt spring and swamp land grants.	Morrill act of 1862, interest from land grant and trespass.	Hatch act of 1887, experiment station.	Morrill act of 1890, supplementary endowment.	
1855			$56,320 00				$56,320 00
1856..							
1857..	$40,000 00						40,000 00
1858..							
1859..	37,500 00						37,500 00
1860..							
1861..	6,500 00		152 25				6,652 25
1862..	10,000 00		218 97				10,218 97
1863..	9,000 00		407 80				9,407 80
1864..	9,000 00		726 09				9,726 09
1865..	15,000 00		1,156 61				16,156 61
1866..	15,000 00		1,094 27				16,094 27
1867..	20,000 00		7,608 38				27,608 38
1868..	20,000 00		592 49				20,592 49
1869..	20,000 00	$30,000 00	17,559 00	$58 96			67,617 96
1870..	20,000 00		1,320 02	2,720 93			24,040 95
1871..	18,250 00	10,500 00	4,135 72	3,785 54			36,671 56
1872..	18,250 00	3,000 00	217 05	7,175 65			28,642 70
1873..	21,796 00	15,602 00	10 13	11,059 06			48,467 19
1874..	13,000 00	15,602 00	150 13	14,061 98			42,814 11
1875..	7,638 00	7,755 50	144 53	14,446 14			29,984 17
1876..	7,638 00	6,755 50	1,773 09	16,830 17			32,996 76
1877..	6,150 00	30,686 80	979 06	15,172 86			52,988 72
1878..	6,150 00	5,686 80	826 60	15,807 09			28,470 49
1879..	4,971 80	16,068 32	712 22	16,978 22			38,730 56
1880..	4,971 80	7,068 32	797 55	17,837 24			30,674 91
1881..	7,249 00	43,720 50	461 95	20,935 25			72,366 70
1882..	7,249 00	8,945 50	358 46	22,507 45			39,060 41
1883..	8,385 00	23,793 00	391 95	30,749 60			63,319 55
1884..	8,385 00	10,526 00	1,259 90	27,909 72			48,080 62
1885..		35,103 00	187 50	29,770 40			65,060 90
1886..		22,617 00		30,461 04			53,078 04
1887..		* 44,040 00	198 20	† 24,611 37			68,849 57
1888..		30,752 50	144 20	32,406 60	$15,000 00		78,303 30
1889..		* 20,973 00	10 50	31,322 69	15,000 00		67,306 19
1890..		* 27,172 00	238 50	32,360 64	15,000 00	$15,000 00	89,771 14
1891..		22,947 50	37 38	34,750 54	15,000 00	16,000 00	88,735 42
1892..		22,947 50	137 38	34,948 12	15,000 00	17,000 00	90,033 00
1893..		18,862 50	10 50	37,927 04	15,000 00	18,000 00	89,800 04
1894..		18,862 50	433 59	44,527 26	15,000 00	19,000 00	97,823 35
1895..		‡ 19,000 00	10 50	45,301 85	15,000 00	20,000 00	99,312 35
1896..		‡ 16,000 00		43,886 40	15,000 00	21,000 00	95,886 40
1897..		‖ 17,700 00		43,779 54	15,000 00	22,000 00	98,479 54
1898..		¶ 17,500 00		47,508 28	15,000 00	23,000 00	103,008 28
1899..		§ 8,750 00	705 00	52,526 11	15,000 00	24,000 00	100,981 11
1900..		§ 72,500 00	175 00	72,298 38	15,000 00	25,000 00	184,973 38
1901‖‖		§ 72,500 00		63,976 79	15,000 00	25,000 00	176,476 79
1902..	100,000 00	¶¶ 1,000 00		64,081 81	15,000 00	25,000 00	205,081 81
1903..	100,000 00	¶¶ 1,000 00		65,573 90	15,000 00	25,000 00	206,573 90
1904..	100,000 00	¶¶ 1,000 00	61 19	67,312 37	15,000 00	25,000 00	208,373 56
Totals.	$662,083 60	$726,937 74	$101,723 66	$1,136,366 99	$255,000 00	$320,000 00	$3,203,112 29

* Including appropriations for weather service.
† October 1, 1886, to June 30, 1887, nine months.
‡ Including $5,000 for institutes and $1,000 for weather service.
§ Including $2,750 for institutes and $500 for weather service.
‖ Including $5,500 for institutes and $1,000 for weather service.
¶ Including $5,500 for institutes and $1,000 for weather service.
‖‖ To June 30. ¶¶ Weather service.

SUMMARY OF INVENTORY, JUNE 30, 1904.

College farm and park, 671 acres @ $70		$46,970 00
Athletic field and drive, 13 acres @ $87.50		1,137 50
Buildings—		
Library and museum, built 1881	$22,000 00	
College hall, built 1856	17,000 00	
Williams hall, built 1869	30,000 00	
Wells hall, built 1877	20,000 00	
Abbot hall, built 1888, add. in 1896	15,000 00	
Chemical laboratory, built in 1871, south end add. 1881	18,000 00	
Machine shops and foundry, 1885, south end add. 1887	15,000 00	
Veterinary laboratory, built 1885	5,000 00	
Horticultural laboratory, built 1888	7,000 00	
Agricultural laboratory, built 1889, imp. 1897	7,500 00	
Botanical laboratory, built 1892	10,000 00	
Armory, built 1885	6,000 00	
Greenhouses and stable, built 1873, 1879; rebuilt 1892 and 1902	6,000 00	
Boiler house and chimney, built 1893-4	3,000 00	
President's and two frame dwellings, built 1874	12,000 00	
Six brick dwellings, built 1857, 1879 and 1884	18,000 00	
One frame dwelling, built 1885	3,500 00	
Howard terrace dwelling, built 1888	13,000 00	
Farm house dwelling, built 1869	2,000 00	
Herdsman's dwelling, built 1867	400 00	
Seven barns at professors' houses	1,050 00	
Horticultural barn and shed, built 1868, '75, '87	1,200 00	
Cattle barn and shed, built 1862	1,500 00	
Sheep barn, built 1865	1,000 00	
Horse barn, built 1871	1,000 00	
Pig barn, built 1871	1,000 00	
Corn barn, built 1878	400 00	
Grain barn, built 1881	1,600 00	
Horse sheds, built 1894	200 00	
Tool barn, built 1881	1,000 00	
Brickwork shop, built 1857	500 00	
Observatory, built 1880	100 00	
Bath house and fittings, built 1902-3	17,000 00	
Ice house, built 1879	100 00	
Paint shop, built 1879	150 00	
Hospital, built 1894	3,000 00	
Dairy barn, built 1897	800 00	
Waiting room street car terminus, built 1902	1,700 00	
Street car track and fixtures, 600 ft., built 1897	360 00	
Lumber shed, mechanical department	250 00	
Silo	210 00	
Coal shed, built 1899	700 00	
Women's building, built 1900	91,000 00	
Farm barn, built 1900	4,000 00	
Dairy building, built in 1900	15,000 00	
Bacteriological laboratory, built 1902	27,000 00	
		402,220 00
Iron bridge over Cedar river, built 1888		1,500 00
Dynamo at Agricultural laboratory		280 00
Bridge to athletic field		516 50
Amount carried forward		$452,624 00

Amount brought forward		$452,624 00
Heat, light and water department—		
Water works equipment	$6,164 40	
Electric light equipment	7,319 70	
Steam heating plant No. 1	8,457 00	
Steam heating plant No. 2	1,212 50	
Steam heating plant No. 3	698 00	
Steam and water stock	360 06	
Steam and water tools and fixtures	434 45	
		24,646 11
Bacteriological Department—		
Apparatus	$2,855 50	
Chemicals	171 78	
Office fixtures	1,210 45	
Books and pamphlets	56 80	
		4,294 53
Botanical Department—		
Herbarium	$9,461 85	
Museum	794 35	
Books	290 80	
Maps and charts	403 51	
Negatives	220 40	
Photographs and engravings	943 05	
Lantern slides	254 50	
Microscopes and accessories	1,489 28	
Glassware	326 49	
Chemicals, stains, etc	32 22	
Office and class-room equipment	751 95	
Garden tools	73 26	
General equipment	69 29	
Laboratory tools	105 83	
		15,216 78
Chemical Department—		
Cases and fixtures	$2,932 37	
Specimens	324 00	
Balances	1,673 25	
Weights	670 20	
Glassware ungraduated	2,740 27	
Glassware graduated	798 00	
Porcelain ware	311 56	
Wooden apparatus	166 95	
Rubber material	70 00	
Platinum ware	1,745 70	
Electrical apparatus	1,178 40	
Hoffman apparatus	140 00	
Miscellaneous apparatus	1,781 25	
Assay room supplies	220 05	
Chemicals inorganic	718 77	
Chemicals organic	243 03	
Tools	49 35	
Hardware	652 33	
		16,415 48
Farm Department—		
Live stock, cattle	$8,795 00	
Live stock, swine	851 50	
Live stock, sheep	1,469 00	
Live stock, horses	1,250 00	
Soils laboratory	1,192 06	
Lower class room	184 05	
Tool barn	808 20	
Students' tool room	165 83	
Registered herd barn	77 70	
Horse barn	214 37	
Amount carried forward		$513,196 90

Amount brought forward		$513,196 90
Farm Department—*Continued.*		
Dairy barn	$28 55	
Grain barn	434 33	
Miscellaneous	126 00	
Meat house	112 20	
Farm house	102 93	
Office	732 56	
Office books and library	1,261 85	
Dairy	896 25	
		18,702 38
Horticultural Department—		
Tools	$201 00	
Heavy tools	462 40	
Teams, harness, etc	490 05	
Grafting and pruning tools, etc	20 90	
Carpenter tools	18 85	
Ice tools	38 50	
Animals in Zoo	140 00	
Spraying outfit	426 80	
Aquatic plants	45 00	
Herbarium	145 00	
Class room	543 00	
Seed room	22 50	
Spraying laboratory	66 95	
Large laboratory	338 80	
Office fixtures	766 15	
Greenhouse tools	268 91	
Greenhouse plants	2,232 24	
Miscellaneous	78 90	
		6,305 94
Department of Mathematics and Civil Engineering—		
Surveying instruments	$3,220 16	
Photographic material	59 25	
Tools and apparatus	646 13	
Class rooms	242 50	
Office furniture	411 86	
Engineering class room	192 55	
Astronomical laboratory	838 50	
		5,610 95
Mechanical Department—		
Office and class room fixtures	$2,474 77	
Experimental laboratory instruments	2,228 36	
Experimental laboratory apparatus	3,370 88	
Drawing and mathematical instruments	171 13	
Iron-working machinery	4,975 79	
Small iron-working tools	1,896 85	
Wood-working machinery	1,440 77	
Small wood-working tools	840 53	
Forge shop	677 61	
Foundry	665 41	
Belting, pulleys, shafting, etc	382 44	
Office supplies and stock	644 06	
Sundry supplies	205 67	
Machine shop, stock	1,905 57	
Foundry, stock	344 05	
Wood shop, stock	261 74	
Forge shop, stock	34 73	
		22,520 36
Amount carried forward		$566,336 53

Amount brought forward		$566,336 53
Department of Physics—		
Office and shop	$768 80	
Mechanics	1,011 30	
Heat	468 40	
Sound	185 50	
Light	1,494 95	
Magnetism	65 00	
Dynamic electricity	2,491 30	
Static electricity	1,119 75	
		7,605 00
Women's Department—		
Furniture, musical instruments, etc	$5,041 30	
Cooking school	531 30	
Wood-working room	432 00	
Domestic art	26 27	
Library	102 39	
Offices	415 00	
Miscellaneous	88 25	
Gymnasium	483 77	
		7,120 28
Department of Zoology and Geology—		
General museum	$17,853 75	
Furniture and general apparatus	1,838 10	
Tools	22 10	
Dissecting instruments	360 53	
Office supplies	549 11	
		20,623 59
Carpenter shop		878 43
Drawing Department—Furniture and equipment		2,289 00
English Department—Furniture and equipment		249 75
Forestry Department—Furniture, tools, etc		624 45
Department of History and Economics		174 55
Library		45,564 40
Military Department		679 90
Physical Culture and Athletics		688 05
President's Office		509 88
Secretary's Office		1,869 16
Veterinary Department—Apparatus and equipment		1,688 35
Hospital		231 00
Farmers' Institutes		596 80
Board Rooms		303 75
Post Office		313 00
Weather Bureau		1,893 43
Guest Room		19 75
Cleaning supplies		181 82
Furniture in Chapel		368 10
Paint shop		373 70
Special Courses		476 00
Total		$661,658 67

SUMMARY OF EXPERIMENT STATION INVENTORY.

Lands donated to the Station—		
80 acres at Grayling, fenced and improved at cost	$1,000 00	
5 acres at South Haven, fenced and improved....	1,000 00	
160 acres at Chatham, including buildings......	4,000 00	
		$6,000 00
Buildings—		
Bacteriological stable	$3,700 00	
Experiment feed barn	800 00	
Veterinary laboratory, experimental rooms	250 00	
House	1,000 00	
Feed mill	100 00	
Station Terrace building	3,000 00	
Seed room	500 00	
Poultry house and yards	625 00	
Storage barn	600 00	
Cold storage fruit house	500 00	
		11,075 00
Bacteriological Department—		
Apparatus	$1,756 60	
Chemicals	406 88	
Office	36 50	
Library	412 75	
		2,612 73
Botanical Department—		
Microscopes	$430 92	
Apparatus	134 68	
Furniture	56 00	
		621 60
Chemical Department—		
Platinum ware	$373 52	
Porcelain ware	65 17	
Chemicals	213 84	
Apparatus	1,012 40	
Glassware	424 69	
		2,089 62
Entomological Department—		
Office equipment	$737 46	
Apparatus	485 30	
Chemicals	44 19	
Books	149 33	
Spraying equipment	59 82	
Miscellaneous	75 68	
		1,551 78
Farm Department—		
Tools and equipment	$1,239 90	
Office	394 45	
		1,634 35
Horticultural Department—		
General apparatus	$457 00	
Office equipment	223 87	
		680 87
Secretary's Office		246 25
Library		3,629 00
South Haven Station, equipment		169 85
Upper Peninsula Station, equipment		396 75
Total		$30,707 80

DEPARTMENT REPORTS.

REPORT OF THE PRESIDENT.

To the Honorable State Board of Agriculture:

Gentlemen—I herewith submit my report as President of the College under your control for the year ending June 30, 1904.

The increase in the number of students, which has marked the progress of the College in recent years, was as large as usual, the entire enrollment for the year reaching nine hundred and seventeen. About eight hundred of this number were enrolled in the four and five year courses. The work of the students throughout the year was of a very high order. Their deportment was also very satisfactory to the faculty.

The Commencement Exercises were held June 19-22. The Baccalaureate Sermon was delivered Sunday, June 19, by the Reverend R. G. Ferguson, D. D., President of Westminster College, Pennsylvania. The Commencement Address was given by Dr. H. C. White of the Georgia Agricultural and Mechanical College. These addresses, together with other information concerning Commencement, can be found in the bound volumes of the M. A. C. Record.

The graduating class numbered 55. Their names and addresses are as follows:

Name.	Address.	County.
Adelman, Arthur, m	Chesaning	Saginaw.
Alger, Archie R., m	Newaygo	Newaygo.
Armstrong, Elvine L., w	Okemos	Ingham.
Balbach, Edward, m	Grand Rapids	Kent.
Baldwin, Robert J., a	Brown City	Sanilac.
Barrows, Marguerite, w	Agricultural College	Ingham.
Bird, Lewis F., a	Millington	Tuscola.
Brody, Clark L., a	Corey	Cass.
Brunger, Clifford I., a	Grand Ledge	Eaton.
Button, Don B., a	Farmington	Oakland.
Carleton, William F., m	Hillsdale	Hillsdale.
Carter, Albertus R., m	Newaygo	Newaygo.
Clark, Lawrence T., a	Howell	Livingston.
Cordley, Bessie E., w	Pinckney	Livingston.
Dodge, Arthur C., m	Lansing	Ingham.
Flint, Paul N., a	Cement City	Lenawee.
Geller, Henry W., a	Focsani	ROUMANIA.
Gurney, Dayton A., m	Caro	Tuscola.
Hahn, Harvey D., a	Brookfield	Eaton.
Hornbeck, H. Newton, a	Croton	Newaygo.
Howard, George V., m	Union City	Branch.
Johns, Elizabeth, w	Wixom	Oakland.
Johnson, Sidney E., m	Lansing	Ingham.
Knickerbocker, Jesse P., m	Clio	Genesee.
Lee, Jewel, w	Laingsburg	Shiawassee.

Name.	Address.	County.
Loew, Frederick A., a	Agricultural College	Ingham.
Maltby, Robert D., a	Brighton	Livingston.
Martin, George E., m	Hartford	Van Buren.
McMullen, George S., a	Grand Ledge	Eaton.
McWethy, Leslie B., a	Traverse City	Grand Traverse.
Merick, Wendell S., m	Flint	Genesee.
Millar, Wilson F., m	Ray Center	Macomb.
Morbeck, George C., a	Ingalls	Menominee.
Palmer, Jessie K., w	Kalkaska	Kalkaska.
Pierce, Paul B., m	Bear Lake	Manistee.
Prost, Jacob H., a	Lansing	Ingham.
Robbins, Gerald G., m	Gladwin	Gladwin.
Rogers, Arthur B., a	Caro	Tuscola.
Rosenberry, Alvin A., a	Oak Park	ILLINOIS.
Ross, Henry T., a	Milford	Oakland
Sanford, F. Hobart, a	Albion	Calhoun
Schneider, Henry J., m	Lansing	Ingham.
Schreiber, Herman, a	Washington	D. C.
Seelye, Elric A., a	Davison	Genesee.
Severance, Howard S., a	South Lyon	Oakland.
Slaght, Gertrude, w	Grand Blanc	Genesee.
Slaght, Katherine, w	Grand Blanc	Genesee.
Taber, Melbert W., m	Oak Hill	Manistee.
Taft, Grace H., w	Agricultural College	Ingham.
Taylor, Charles B., a	Oxford	Oakland.
Thompson, William O., a	Indianapolis	INDIANA.
Walker, Harry G., m	Grand Blanc	Genesee.
White, George W., m	Solon	Leelanau.
Woodbury, Charles G., a	Lansing	Ingham.
Wright, William J., a	Webberville	Ingham.

The large increase in attendance compels us to meet serious problems in the way of more class rooms, equipment and teachers. During the past year drawing was taught in the upper story of four different buildings, mathematics in four buildings, English in several buildings. All our shops and laboratories are greatly overcrowded. We have been compelled to cut down the time of some classes, combine others and resort to all sorts of schemes and devices to carry on the work. It is needless to say that good work cannot always be done under such conditions. Next year we shall have to find more room for our Department of Physics and also more class rooms for mathematics and civil engineering. There is no possible place for these additional rooms unless we put in use some dark, damp basement, which, under ordinary conditions, would not be thought of. Our schedule of recitations covers the time from eight A. M. to six P. M. A number of class rooms and laboratories are in use eight and even nine hours each day. Recitations are held on Saturday forenoons and our schedule for next fall term will even require some students to work Saturday afternoons. Unless some relief can be secured in the way of additional buildings, the time is near at hand when we shall be compelled to limit the number of students in attendance.

When the College was organized, the age limit for entrance was set at 15 years. With the number of secondary schools throughout the State and with the changes in the character of the work given at the College, it is believed that this limit should be raised. A 15 year old boy or girl is too young and immature to undertake college work.

A number of laws which were enacted when the College was first organized are still on our statute book. The character and work of the

institution has outgrown many of these laws. It is undesirable and even impossible to comply with them. It is recommended that a careful revision of these laws be made.

CHANGES IN FACULTY.

During the past year there has been but one change in the faculty. Mr. Martin D. Atkins, Assistant Professor of Physics, resigned at the beginning of the year to accept a position at Lake Forest Academy, Illinois. This vacancy was filled last April by the election of Mr. A. R. Sawyer of Lexington, Kentucky, as Professor of Physics and Electrical Engineering.

Y. M. C. A.

There has been a strong, vigorous Y. M. C. A. organization in the institution for many years. It has been felt for some time by the students and faculty that a secretary should be employed to devote his whole time to this work. To bear the expense of such a secretary, there was raised by subscription and dues among the students and faculty $992.75. About $562.50 of this sum was subscribed by the faculty and instructors. Mr. Bert Wermuth of the class of 1902 was placed in charge of this work. The results were very satisfactory indeed. This plan will be continued.

The College suffered great loss in the death of the Honorable Franklin Wells, who had been connected with the Board for thirty years, and since 1883, with the exception of four years, President of the Board. He died at his home in Constantine very suddenly, July 3, 1903. He had been in attendance at Board meeting and Commencement about three weeks before this time; he was then in excellent health. In recognition of his thirty years of loyal and efficient service to the institution, the faculty and other friends arranged to present to the College an oil painting of Mr. Wells on Commencement Day, and to Mr. Wells an album containing the autographs and photographs of his associates in the past years and also of his friends at the College. Dr. Edwards made the presentation in the following words:

"In the year 1873, Governor Bagley appointed to the Michigan State Board of Agriculture the Hon. Franklin Wells of Constantine. From that time until the present day, a stretch of over 30 years, Mr. Wells has been a member of the controlling board of this College. Nor is this all. The Board of Agriculture was organized in 1861. Curiously enough, almost from its very birth the name of Wells has been that of the President of this Board throughout some 33 years. On the organization of the Board in 1861, Judge Hezekiah G. Wells, of Kalamazoo, was appointed on the Board, and in 1866 became its President, holding the office until his death in 1883. At that time, in recognition of the zeal, earnestness and far-sightedness that he had displayed in the affairs of the College, Mr. Franklin Wells was elected President of the Board. He remained President until 1899, and at the beginning of the present year, 1903, he was a second time placed in the position he had so long adorned.

During all these years of service, Mr. Wells has displayed a degree of devotion to the best interests of the College, a purity of purpose, a willingness to give time and anxious thought to its business, a keen business sense in the financial affairs of the College, a broadness and clearness of conception and a firmness and steadfastness of purpose in regard to the design and policy of the College, that has met with general and hearty recognition. Especially have these qualities appealed to those who throughout these years have been brought most closely in contact with the man and have most intimately known his work. His is not a character which trumpets itself to the world, but it is one that by its modesty, integrity, forcefulness and kindliness attracts and firmly holds the highest respect and esteem of his associates.

In view of these facts, friends of Mr. Wells here at the College and elsewhere have caused to be painted by Prof W. S. Holdsworth, of the College, this portrait, and have purchased it with the view of placing it at the College as a permanent memorial of 30 years of unselfish and fruitful public service. Moreover, as a memento of the occasion, the donors have caused to be prepared this album containing autographs of the contributors to the Wells portrait fund, and photographs of associates on the Board of Agriculture from the earlier days down to now. In behalf of the friends who have planned and made possible this testimonial of esteem, I take great pleasure in presenting to the College this portrait of the Hon. Franklin Wells, of Constantine, and to Mr. Wells himself, this album."

In accepting the painting on behalf of the College, the President of the institution spoke, in part, as follows:

"On behalf of the College, I accept this picture of Mr. Wells, and promise to the donors that it will be given a conspicuous position in one of our halls, and be carefully guarded from harm.

This occasion is unique in the history of the College, or in the history of any other public institution. It is very rarely that a good man is permitted to serve as a member of a board of control for 30 years. There are not many men endowed with such natural ability and with such genius for work as to entitle them to such continuous service. But above all, men are few indeed, who, endowed with the capacity for such high service, are willing to give the time and make the sacrifice without compensation. Do you realize what 30 years of such service means? Could all his work for the College be grouped into one period it would mean more than three years of time. Had all his trips to and from the College been spent in one continuous journey, it would have carried him twice around the world. But the labor of the days spent in actual service is small in comparison with the thought, worry and anxiety for the institution carried by him, day and night, for these many years. For everybody who knows Franklin Wells knows that his own personal business was never closer to his heart than the interests of this institution have been. We all know how faithful he has been to the trust committed to his charge, and what valuable service he has rendered this College. Why not tell him so? We all admire and love him because he is honest, because he is courageous, kind-hearted and true. Why not tell him so?

Those of us who know him well understand that while the memory of

this day will be very pleasant to him, yet he does not enjoy hearing us say these things. But I know no one to blame for it but himself. Had he performed his tasks in an ordinary way—had he gotten tired or discouraged or decided to use all his time in his private business, we would not feel it our duty to say these things of him now.

But we wish him to know that we do not praise him today for his long service nor for his efficient service; but we do admire and applaud him today because of those qualities of manhood which have made such service possible. We congratulate him today and sincerely trust that he may serve this College as the honored President of its Board of Control for many years to come.

'Honor and reverence and the good repute
That follows faithful service as its fruit,
Be unto him whom living we salute.'"

The words used on this occasion set forth in a small degree the estimation in which Mr. Wells was held by his associates and the faculty. The institution was represented at the funeral by the following persons: President Snyder, Dr. Beal, Prof. Taft, Prof. Smith, Prof. Kedzie and Mr. Gunson.

It is not the purpose at this time to set forth the results of Mr. Wells' work. It may be noted, however, that he, perhaps more than any other person, deserves the credit of holding the institution strictly to the lines of work laid down by its founders. The wisdom of his course, while called in question very often at the time, is now most heartily approved by the friends of the institution.

Summary of enrollment during the past year.

	Agricultural.	Mechanical.	Women's.	Totals.
Post-graduates	1	1	2	4
Class of '04	35	23	13	71
Class of '05	24	30	30	84
Class of '06	16	52	15	83
Class of '07	73	131	36	240
Sub-freshmen	57	97	30	184
Special Students	18	19	83	120
Special short course students:				
Beet sugar 13				
Cheese 25				
Live stock 55				
Creamery 35				
Fruit 9	137			137
Totals	360	353	209	923
Deduct names repeated				6
Final total				917

Students entering during the year, not including those in special short courses.

	Male.	Female.	Total.
Number entering	275	102	377
Average age	19-8	19-5	....
Schools previously attended:			
High school	184	76	260
District	49	14	63
College	25	5	30
Private	17	7	24
Entered college on:			
High school diploma	79	37	116
Teacher's certificate	5	5	10
College standings	30	5	35
Examination	49	7	56
Age	29	4	33
Tenth grade standings	44	24	68
Eighth grade diploma	39	20	59
Support while here:			
Father	139	72	211
Self	79	14	93
Parents and self	26	....	26
Mother	10	8	18
Not given	9	1	10
Guardian	4	2	6
Other sources	8	5	13
Occupation of father:			
Banker	2	1	3
Carpenter	8	....	8
Clerk	10	7	17
Clergyman	10	1	11
Deceased	34	14	48
Engineer	9	....	9
Farmer	87	29	116
Lawyer	10	2	12
Manufacturer	12	5	17
Mechanic	4	2	6
Merchant	33	12	45
Miscellaneous	37	19	56
Painter	3	1	4
Physician	11	4	15
Real estate	1	3	4
Teacher	4	2	6
Proposed occupation after leaving college:			
Mechanical engineer	72	....	72
Civil engineer	17	....	17
Electrical engineer	14	....	14
Farmer	37	....	37
Chemist	9	....	9
Forester	4	....	4
Teacher	2	28	30
Mechanic	5	....	5
Miscellaneous	26	1	27
Not given	23	28	51
Undecided	66	45	111

Church membership.

	Members.	Preference.	Total.
Baptist	18	21	39
Catholic	12	5	17
Church of Christ	1	1	2
Congregational	27	33	60
Disciple	....	1	1
Episcopal	14	5	19
Evangelical	1	1	2
Jewish	1	1	2
Lutheran	7	2	9
Methodist	39	65	104
No preference	....	....	65
Presbyterian	26	14	40
Reformed	3	1	4
United Brethren	2	....	2
Universalist	5	6	11

Counties represented in the entering class.

Allegan	7	Kalkaska	1
Alpena	1	Kalamazoo	3
Antrim	4	Kent	17
Barry	9	Lapeer	5
Bay	7	Lenawee	12
Benzie	4	Livingston	3
Berrien	6	Mackinac	1
Branch	4	Macomb	5
Calhoun	12	Manistee	1
Cass	5	Mason	1
Charlevoix	5	Mecosta	1
Cheboygan	1	Menominee	1
Chippewa	1	Missaukee	1
Clinton	5	Monroe	1
Crawford	1	Montcalm	5
Dickinson	1	Muskegon	3
Eaton	5	Oakland	9
Emmet	1	Oceana	1
Genesee	10	Ottawa	5
Gogebic	1	Saginaw	5
Grand Traverse	2	Sanilac	6
Gratiot	4	Schoolcraft	1
Hillsdale	9	Shiawassee	11
Houghton	2	St. Clair	3
Huron	10	Tuscola	3
Ingham	60	Van Buren	6
Ionia	3	Wayne	26
Iosco	2	Washtenaw	1
Jackson	10	Wexford	3

Other States represented.

California	1	Montana	2
Colorado	1	New York	10
Florida	1	Ohio	6
Georgia	2	Pennsylvania	2
Illinois	4	Virginia	1
Indiana	4	West Virginia	2
Massachusetts	1	Wisconsin	1

Respectfully submitted,

J. L. SNYDER.

Agricultural College, Mich.
June 30, 1904.

REPORT OF THE DEPARTMENT OF PRACTICAL AGRICULTURE.

To President J. L. Snyder:

The following is the report for the Department of Practical Agriculture for the year ending June 30, 1904:

DIVISION OF ANIMAL HUSBANDRY.

Mr. H. W. Norton succeeded Mr. Geo. C. Humphrey as Instructor in Live Stock, assuming the duties of the position shortly before the opening of the College year. About December 1, 1903, Mr. Norton was given leave of absence for five weeks to study methods of dressing, cutting and curing meats at the Minnesota Agricultural College. This preparation was necessary in order to provide for demonstrations relative to a study of quality in meats taken up by both senior and special students during the winter term. This work has added greatly to the usefulness of the course.

The following students received instruction in Animal Husbandry during the year, viz.:

Study of Breeds and Stock Judging, 44 four-year Freshmen, 10 hours per week, 12 weeks.

Study of Breeds and Stock Judging, 58 five-year Freshmen, 10 hours per week, 12 weeks.

Study of Breeds and Stock Judging, 7 Specials, 10 hours per week, 12 weeks.

Stock Breeding, 14 Sophomores, 5 hours per week, 6 weeks.

Stock Breeding, 10 Specials, 5 hours per week, 6 weeks.

Stock Feeding, 9 Juniors, 5 hours per week, 12 weeks.

Stock Feeding, 15 Specials, 5 hours per week, 12 weeks.

Advanced Stock Judging, 15 Seniors, 10 hours per week, 10 weeks.

Advanced Stock Judging, 3 Specials, 10 hours per week, 10 weeks.

Methods of Registration, Meat Cutting, and Commercial Live Stock Studies, 16 Seniors, 10 hours per week, 12 weeks.

Methods of Registration, Meat Cutting, and Commercial Live Stock Studies, 5 Specials, 10 hours per week, 12 weeks.

Animal Nutrition, 14 Seniors, 10 hours per week, 12 weeks.

Animal Nutrition, 7 Specials, 10 hours per week, 12 weeks.

Special Short Course, Live Stock, 54 students, 10 hours per week, 6 weeks.

Live Stock Equipment.—During the past year a rigid selection has been practiced and considerable fresh blood added to the herds and flocks. The equipment now consists of 92 head of registered cattle representing the following breeds, viz.: Shorthorn, Hereford, Aberdeen-Angus, Galloway, Holstein, Guernsey, Jersey, Ayrshire, Brown Swiss, and Red Poll. The flock of pedigreed breeding sheep, not including lambs, comprises 80 head representing the following breeds, viz.: Merino, Southdown, Dorset, Shropshire, Hampshire, Oxford, Lincoln, and Cotswold. There are at present about 50 head of registered breed-

ing pigs representing the following breeds, viz.: Chester White, Yorkshire, Tamworth, Berkshire, Poland China, Duroc Jersey, and Victoria.

The dairy barn has undergone some changes during the year. Permanent meal bins have been built in front of each row of cows in such a way as not to interfere with feeding operations and at the same time leave a wide passageway. There is a separate compartment for each animal. A certain amount of the grain mixture is weighed out and placed in each compartment once a week. This lessens the labor of feeding and prevents any possibility of error when different rations are being used. A silage car with weighing facilities for both silage and hay has been constructed and put into use which also greatly lessens the labor involved. The milk room has been changed thereby providing more comfortable and sanitary quarters for three instead of two stock bulls, all of which have access to yardage. A water system has been added to the building and a root cellar constructed beneath the bridge leading up to the barn. The work of yard grading has also been continued and a new and more desirable entrance made into the ground floor of the building. The work of removing the grade herd barn and silo to a more favorable location has been commenced.

The last period of lactation for the dairy herd ended about October 1, 1903. During this year the average production from the 20 cows comprising the herd was 7,444.28 pounds of milk and 343.67 pounds of butter. The majority of these cows produced but ten and one-half months each. The methods of feeding employed were not forced ones for record making, but simply moderate, practical feeding.

The sheep yards east of the sheep barn have been entirely removed and replaced with new ones constructed very largely from woven wire. Every attempt has been made with the means available to strengthen the various breeding flocks of sheep, the older ones being disposed of and replaced by the best and most vigorous young animals. The entire ram flock must be disposed of during the present season and replaced by a fresh stock not akin to the females.

The work of providing facilities for the extensive breeding of swine has continued throughout the year, during which new cots and additional fencing has been added. This division is now about complete and ready for operation.

Field No. 5 of the College Farm, the one nearest the buildings, has been set aside to be used exclusively for the production of root soiling and forage crops. It is conveniently located for handling soiling crops and is within easy access when it is desirable to pasture off certain portions. This season this field is producing rape, succotash, corn, roots, and alfalfa.

DIVISION OF AGRONOMY.

During the year the work in Agronomy and Soils has been enlarged. A course of lectures on crops, continuing through one term for the four-year men and through one and one-half terms for the five-year men, has been introduced. Rational methods of increasing yields and improving the quality of our crops, are given much stress in this course.

The work in farm mechanics has been broadened with excellent results.

The rearranging of our laboratories and the addition of furniture and

apparatus has made it possible to accomplish the work planned for the year, but with the larger classes promised for the coming year our facilities will be taxed to the utmost.

Mr. O. O. Churchill did good service as Instructor in Agriculture during the year till May 20, 1904, at which time he resigned to accept the important position of Experimenter in Grain Improvement at the North Dakota Experiment Station. During the remainder of the College year Mr. L. B. McWethy, a Senior in the Agricultural course, devoted what time he could spare to taking up the work left by Mr. Churchill.

The amount of time devoted to lecture and laboratory work in Agronomy and Soils during the year is as follows:

Fall term—three classes requiring six hours daily

Winter term—six classes requiring eight hours daily.

Spring term—five classes requiring seven to ten hours daily.

During the Winter term the Instructor has complete charge of one class and during most of the Spring term, two classes. During the whole year a part of the laboratory work was in charge of the Instructor and an occasional lecture or quiz was given by him.

In addition to the above work, more or less investigation and experimental work has been carried on. One very important line is that of wheat improvement. In this work it is sought not only to increase the yield of grain but also, especially, to increase the protein content. In three years the protein content has been changed from 9.13% to 11.27% in Dawson's Golden Chaff, while other milling qualities have been improved.

Numerous talks upon Agronomy lines have been given before institutes, granges, farmers' clubs, and other meetings.

Two popular bulletins along the same lines have been prepared.

The stands of corn in three of our College fields attest the importance of rational methods in saving seed corn.

DAIRY DIVISION.

The work of the Dairy Division during the past year has been partly instructional and partly investigational. The amount of instructional work is indicated below:

Number Special Creamery Students,	33,	time 6 weeks.
Number Special Cheese Students,	25,	time 4 weeks.
Number Farm Dairy Students,	21,	time 3 weeks.
Number Sophomores,	16,	time 10 weeks.
Number Juniors,	3,	time 10 weeks.
Number Seniors,	4,	time 37 weeks.

Four creameries and one cheese factory have been visited by request; five addresses have been delivered at dairy meetings; one two-day and two one-day institutes have been attended; about 50 newspaper articles have been written solely in the interests of the College. Fifty-two creameries and 33 cheese factories in the educational scoring tests have occupied a considerable portion of the time of this division through correspondence. These tests have been of great value in educating butter and cheese makers.

The investigational work comprised: First, studies in cheese mak-

ing, the results of which have been published as Special Bulletin No. 21; second, no less than 75 tests of the relative merits of pasteurized and unpasteurized butter which have positively demonstrated the advisability of pasteurizing the cream from ordinary milk for butter production; and third, studies along the line of sanitary milk production which have necessitated visits to nearly a dozen dairy farms, the results to be published in a forthcoming bulletin.

Yours respectfully,

R. S. SHAW.

REPORT OF THE DEPARTMENT OF HORTICULTURE.

To President J. L. Snyder:

I have the honor to present herewith my report as Professor of Horticulture and Landscape Gardening for the year ending June 30, 1904. The year has been one of steady growth in the several branches of the department, and I take pleasure in setting forth the essential details of its progress.

INSTRUCTION.

But one change has been made in the courses offered by the Department since the report of last year. In the Fall term of the Senior year two distinct lines of study are carried by the Seniors instead of but one. Formerly the entire term was devoted to Harvesting and Marketing Fruits; now the first half of the term is devoted to that subject, while Plant Breeding occupies the last half term.

The number of students taking work in the Department varies so little from the numbers given in 1903 that it is not thought worth while to give the figures for the different courses. In only one class was there a marked falling off in numbers. Owing to the installation of the five-year course, and consequent changes, there were fewer Sophomores than we usually have to take the work in Vegetable Gardening.

The laboratory work remains much the same this year as last. It should be noted that this is the first year in which laboratory work wholly takes the place of the old system of manual labor. The year's trial of the new system justifies to the highest degree the hopes with which it was inaugurated. It should be said that all of the ground formerly covered as strictly educational work is covered by the new system—it is only the repeated performing of routine work that has been eliminated. Abundant opportunity is now given to take a hand in doing the routine work on Saturdays and during vacation, and with suitable wages.

The special six weeks' course in Horticulture was given as in previous years, with about the same number of students and the same degree of success.

IMPROVEMENTS TO BUILDINGS.

The work of renovation begun last year has been carried forward as rapidly as funds for the purpose could be obtained. In the basement a well-equipped room for the study of spraying mixtures has been completed and a start made in furnishing a larger room for the exhibition of spraying implements. Before further improvements are made in the basement, steps must be taken to lower the drains leading from the building. Back-water from the drains in the early spring did much damage to the newly finished rooms and the equipment in them. New cement floors were laid throughout the basement, and the drains in and about the building were put in good shape. The most notable improvement to the Horticultural laboratory is the addition of a model, iron-frame greenhouse on the south side of the building. The greenhouse is but a small one, 20x20 feet, but admirably serves its purpose, that of furnishing a greenhouse room for laboratory work. The greenhouse is a gift from Lord & Burnham Co., Irvington-on-the-Hudson, N. Y. It is worth recording that it was erected almost entirely by students of the Junior class who had just completed a course in greenhouse construction.

ORCHARD, GARDEN AND GROUNDS.

No changes worthy of note have been made in the orchards during the past year. A currant and gooseberry plantation east of the irrigation stand-pipe, set out 18 or more years ago, was removed; the location of the strawberry plantation was shifted and the number of varieties was cut down. In the early spring, students who had taken the class-room and laboratory work in pruning were hired to prune the College orchards under the direction of C. A. Mosier.

The grounds have received little more attention than that necessary to keep them up. A few minor improvements may be noted, as: The completion of a road back of the Faculty Row dwelling houses; the levelling and draining of the athletic field; and the planting of a large bed of rhododendrons and laurels. Attention is again called to the increased number of buildings to look after; more and more picnics from year to year; and additional work on the grounds from several other causes. With this increase of labor and the higher price of workmen, it is impossible to make permanent improvements, though many opportunities for such are at hand. During the past season the beauty of the grounds has been much marred through the digging of tunnels for the new heating system.

The garden, as in years past, was largely planted and cared for by students as a part of their laboratory work. One of the features of the garden this year is a plantation of curious and little-known vegetables and herbs; another, is a collection of French vegetables, giving us many species and varieties not commonly grown in the United States. The vegetable garden is intended to illustrate gardening to students and to supply the Experiment Station with such tests as it may call for.

INSTRUCTORS.

Mr. Thomas Gunson, Mr. C. A. McCue, Mr. A. G. Craig, and Mr. H. Sherman have assisted in the teaching of the Department and in

carrying on the routine work. Mr. Craig was paid from the funds of the Department during the several months of his services. All have ably performed their duties. It is reasonable to suppose that we shall accomplish more as the two new men, Mr. McCue and Mr. Craig, become familiar with their work.

The Department should have an assistant professor. Fourteen courses, including laboratory work, are now offered in Horticulture; there is much horticultural work out-of-doors in the orchards, garden, and on the grounds; there are many annoying and burdensome non-horticultural matters to be attended to, as the errand, the ice, the fuel, the vegetable, and the scavenger work of the College community. Then, too, the head of the Department is called away from the College more and more to attend horticultural meetings, institutes, etc. The responsibility of all this work should be shared and carried in part by an assistant professor.

All of which is respectfully submitted,

U. P. HEDRICK,
Professor of Horticulture and Landscape Gardening.

Agricultural College, Mich.
June 30, 1904.

REPORT OF THE DEPARTMENT OF BOTANY.

President J. L. Snyder:

Herewith I present you my brief report for the year ending June 30, 1904. On account of some changes in the courses, the number of students receiving instruction has not been so large this year as during several of the preceding years. This is the list:

Class.	Subject.	Term.	Hours per week.	Students enrolled.
Agricultural juniors	Parasitic fungi	Fall	9	30
Agricultural juniors	Grasses and other forage plants	Winter, 5 wks.	5	10
Agricultural juniors	Weeds	Winter, 5 wks.	5	10
Agricultural juniors	Ecology	Spring	3	17
Agricultural juniors	Trees and shrubs	Spring	2½	21
Agricultural sophomores	Plant histology	Winter	9	16
Agricultural sophomores	Ecology	Spring	3	15
Agricultural sophomores	Systematic (extra courses for forestry)	Spring	3	3
Agricultural sophomores	Systematic	Spring	3	13
Agricultural sophomores	Trees and shrubs	Spring	2½	19
Agricultural freshmen	Fruits and seeds	Fall	4½	79
Agricultural freshmen	Systematic	Spring	3	58
Agricultural freshmen	(Preliminary course)	Fall	2	9
Agricultural freshmen	Fruits and seeds	Fall	4½	37
Agricultural freshmen	Histology	Spring	7	22
Agricultural sub-freshmen	Elementary	Spring	2	31
Agricultural sub-freshmen	Elementary	Spring	2	28
Total				418

MICHIGAN FLORA.

More than half of the long summer vacation of 1903 was spent in thoroughly revising the list of plants growing in Michigan. Since then, nearly as much more time, in addition, has been given to the work. Such a flora was much needed by all botanists of the State. No one else seemed willing to undertake the task. Most of the proof of the flora has been read for the fourth report of the State Academy of Science.

Besides the above, several other contributions to the report of the State Academy of Science have been made by the teaching force of this College.

THE STATE GRANGE.

For many years past, the officers of the State Grange have uniformly befriended the Agricultural College whenever it was possible. In like manner, the Faculty of this College has rendered assistance to the Grange. Last winter a session of the Grange was given up to a lecture on "Teaching Agriculture," and later, two short, popular bulletins were prepared on "Grasses and Forage Plants," to be used in reading courses and by lecturers of subordinate Granges, for the months of June and July.

TEXT BOOKS FOR CLASSES IN BOTANY.

Concerning this topic, many inquiries are received from teachers. For a course in beginning botany, and another in fruits and seeds, much dependence is placed on the study of plants grown in the botanic garden, not only in a fresh condition, but dried, or, in case of fleshy fruits, preserved in jars of four per cent formalin. We have, in liberal quantity, hundreds of kinds of seeds and fruits, ready for study at any time of the year. To aid in acquiring a clear understanding of the terms used, a small glossary has been prepared by Professors Beal and Dandeno, which may be had by each student at a cost of only 15 cents. This is the only text book needed during the first two terms.

THE VALUE OF A BOTANIC GARDEN AND AN AGRICULTURAL MUSEUM.

In summer, the chief attractions this College possesses over any others in the State in the way of exhibits, are the broad, undulating lawns, the trees and shrubs, the orchards, the botanic garden, the fields, the cattle, the laboratories, the experiments, etc., and we are not likely to overestimate the importance of these features, even when considered as advertisements. In winter, some of the chief attractions for visitors are the museum, greenhouses, domestic animals and the laboratories in variety. Fourteen years ago, by a gradual process, we had gathered and arranged a unique botanical museum that was much frequented. It contained a fine assortment of Michigan woods, prepared in a variety of ways; corn, wheat and other cereals; dry fruits and seeds; and many monstrosities. There were many small things that were made of wood, in various stages of manufacture. Of corn, we had the best assortment that I ever saw anywhere. But alas! One night our first botanical laboratory went up in flame and smoke; and one thing after another, including the inactivity of the professor of botany, has kept crowding

back the building of a new botanical museum, until a new generation of teachers and members of the Board of Agriculture have come to manage and occupy the College.

We need a new museum for illustrating agriculture, horticulture, botany and forestry, in addition to the one we have now, devoted to zoology and geology, but before securing a new building, with substantial and ample quarters, it will be necessary for some of us to tell those in authority over and over again the value of such a collection, well put up and well cared for. Such a museum would be a great advertisement and a great educator. We already have several nuclei for such a museum. For example, the attic and the basement of the present botanical laboratory are stuffed with boxes and logs rescued from the fire, with others brought from the Chicago Exposition, and all are covered with the dust of years.

I almost despair of ever securing money for building another good museum, but my plan is to make a small beginning, trying to secure a single plain room in which I can place our relics, that all of you may become sufficiently interested to see the value of a larger and finer museum.

It will be wiser to be content with something small to start with. I will illustrate my meaning by quoting from a recent report of the President and the Professor of Botany of Massachusetts Agricultural College: "A garden containing all the shrubs and trees of Massachusetts has long been the dream of the college, but the time has never seemed ripe for such undertaking.

"The idea of a Massachusetts garden at the Massachusetts Agricultural College has been contemplated for some years. In 1870, there was made by Ignatz Pilat of New York, an elaborate water-color plan of a proposed botanical garden, designed on the most artistic and comprehensive basis. The plan of this garden was to include all of the land east of the Insectary and Botanic Museum to the President Clark boundary. It was also to include a large pond for aquatic specimens, to be situated on land just northeast of the Insectary, and now utilized for market-garden purposes; and a small pond was to be located in the ravine southeast of the upper plant house.

"In the thirteenth annual report (January, 1876) President Clark states that he is 'still hopefully waiting for the fund of $50,000 for the endowment of the botanic gardens.' The plan recommended is also more elaborate and costly than is required at the present time. To construct the garden as Pilat designed would cost $50,000, and an additional fund of $5,000 per annum would be required to maintain it.

"The Botanical Department has long felt the necessity of a Massachusetts garden, in order that students might become familiar with the native trees and shrubs. Some of the students during the past years have gone into landscape work, and certain members of the present senior class are expecting to do likewise. These students have not been qualified to work for landscape gardeners because they have been ignorant of the common plants of the State; neither has it been possible, with our equipment, to give them this knowledge. If they are sent out by landscape gardeners, as they frequently are, to collect certain species, they are not competent to recognize them. It is very essential, therefore, that students should know at least every native tree and shrub of

this State, besides a great many cultivated ones, before they can expect to become efficient men for landscape gardeners. Every student that leaves this institution without that knowledge injures it. With our collection of ornamental trees and shrubs, and the establishment here of all the native species, the elective courses could be easily arranged so that students desiring to fit themselves for the overseeing of large estates or to become associated with landscape gardeners could be amply qualified for such work. Furthermore, there should be established here at the College strong courses in landscape architecture, forestry and sanitary engineering, to round out and supplement a knowledge of the flora of the State.

"There is no feature so valuable in a collection of plants from an educational standpoint as a collection following a natural sequence, or, in other words, a synoptical collection. The Arnold Arboretum has about four acres devoted to this purpose, and one can obtain a better idea of shrubs from this collection than from any other in the United States. Such a collection at the College would be desirable, and should contain a large number of the herbaceous plants, such as our most important asters, golden rods, old-fashioned herbs and flowers, medicinal plants, etc."

The above is the account of the dream of the college officers in Massachusetts, extended for over a third of a century. In the early days of this College, more than one professor had selected a spot and dreamed of a botanic garden, when ample means should be given for the undertaking.

In 1870, when the present Professor of Botany began his work at M. A. C., he did not wait for a generous sum with which to start a garden, but began to dig and plant in a very small way, trying in succession many different schemes. He thought a small garden right away preferable to waiting for a long time for a large one. Besides, it doesn't cost much to experiment in a small way, till one finds out just what he wants and learns how to do the work. By a slow process at little cost, I have learned that a garden cannot be planted once for all time, without great expense. Plants need a rotation; a change from one place to another. The soil becomes depleted; insects and fungi find their favorite plants and settle down in great numbers to live on them. Most shrubbery does better with an occasional change. Had our botanic garden waited for $5,000 per year, or even $500 per year, it probably would have remained only a dream even to the present time. Not counting a share of my own time, our botanic garden, consisting of two acres, where 2,000 kinds of plants grow, costs not far from six hundred dollars a year, by far the cheapest garden of its size and quality in existence. The Professor of Horticulture says that not less than $5,000 per year, not including greenhouses, should be used in the maintenance of a botanic garden at this College.

During three or four months of the year, this small garden attracts more visitors than any other one thing or department of the College. How would it be with a larger and more complete garden?

The points referring to the origin of our botanic garden, illustrate my way of starting a museum.

THE HERBARIUM.

The additions made during the past year are enumerated below.

SEED PLANTS, FERNS AND THEIR ALLIES.

Meehan's Sons, Varieties of Thuya Occidentalis and Juniperus..	35
C. G. Pringle, Mexican Plant	280
W. W. Eggleston, Rutland, Vt	156
C. F. Wheeler, Washington, D. C., Fruits of Oaks and Coniferas..	28
W. S. Cooper, Alma, Mich	51
A. A. Heller, California	380
U. S. Dept. of Agriculture, Festucaceae	54
Home Collections	136
S. M. Tracy, Gulf Coast Plants	392
C. F. Baker, Nevada Plants	396
C. F. Baker, Nicaraugan Plants	89
	1,997

MOSSES AND LIVERWORTS.

C. F. Baker, Plants from Nicaragua	20

LICHENS.

C. F. Baker, Plants from Nicaragua	5

FUNGI.

W. A. Kellerman, Ohio, Fascicles VII., VIII., IX., and others..	30
Briori & Cavara, Fascicle XV., Economic	25
Seymour & Earle, edited by G. P. Clinton	100
	155
A. A. Heller, Porto Rico Plants	43
Fungi Columbiana, Vol. XIX	100
C. F. Baker, Plants in Nicaragua	8
S. M. Tracy, Plants from the Gulf Coast	12
Home Collections	65
	228

ALGAE.

Collins, Holden and Satchel, Fascicles XXII., XXIII., XXIV....	150
Total additions for the year	2,555

GENERAL SUMMARY OF PLANTS IN THE HERBARIUM.

Seed Plants, Ferns and their allies	66,960
Mosses and Liverworts	1,974
Lichens	1,186
Fungi, Home Collections	15,753
Algae	2,020
Total	87,893

DONATIONS TO THE BOTANICAL DEPARTMENT.

From I. B. Bates, Flint, Mich., two pints of paint.

From B. O. Longyear, Agricultural College, Mich., Living plants of Monarda fistulosa alba.

From C. D. McLouth, Muskegon, Mich., 200 pits of Prunus pumila.

From J. A. Kooyens, Holland, Mich., living plants of Viola pedata.

From O. C. McLouth, Addison, Mich., herbarium specimens of Quercus Alexanderi.

From S. Alexander, Birmingham, Mich., two samples of nuts of Quercus Alexanderi.

From Brown Bros., Lansing, Mich., nice board of wavy grain of Georgia Pine.

From H. C. Skeels, Joliet, Ill., 17 kinds of living plants.

GIFTS TO OTHERS.

To the U. S. Bureau of Forestry, 125 unmounted photographs.

To W. H. Scherzer, for the State Normal College, Ypsilanti, 222 species of Seeds of Weeds and Grasses.

Thanks are again tendered to Professor J. B. Dandeno and Instructor B. O. Longyear for faithful services during the year now closing.

W. J. BEAL,
Professor of Botany.

Agricultural College, Mich.
June 30, 1904.

REPORT OF WOMEN'S DEPARTMENT.

To the President:

The report of the Women's Department for the year 1903-1904 is herewith submitted.

The enrollment for the year was 210. The Women's Building accommodated 119, while 26 had rooms in the neighborhood and were under the immediate supervision of the department. This increased number taxed the seating capacity of the dining room and it became evident that some plan should be made for selecting the candidates for entrance in the future. It is a significant fact that 84 of these students were enrolled as specials. Before the end of the year this number was still further increased by young women who changed their course and selected their studies.

The various lines of work have been carried on as usual. The new course in wood work was given for the first time in the fall term by Mrs. Gingles, and that in laundering was given in the winter term by Miss Carpenter. The lectures in Home Nursing were given by Mrs. Barber throughout the fall term rather than during the half term only, as heretofore.

Miss Lyford, instructor in Domestic Science for the past four years, sent in her resignation early in the spring and will take advanced work at Drexel Institute next year. Mrs. Gingles, who has been in charge of Domestic Art for the past year and assistant for the preceding year, expects to enter Teacher's College, Columbia University, in the fall. Both these ladies have been efficient workers and the department wishes to express its appreciation of their services and the hope that the future has abundant success in store for them.

The other members of the teaching force are retained. Mrs. Haner, who has been absent on leave, will return to take charge of the work in Domestic Art with Miss St. John as assistant; Miss Carpenter will be in charge of Domestic Science and of Club C; Miss Freyhofer, instructor in music, with Miss Mack as student assistant; Miss Avery director of physical training and health officer.

The shower bath rooms, in connection with the gymnasium, were fitted up at the beginning of the year at considerable expense, and a set of lockers was added to the equipment of the town students' rooms. Both these improvements were much needed. A new Steinway Grand was placed in the parlor last fall and has added greatly to the success of the recitals which have been given every term.

The Music Festival, held May 19, under Miss Freyhofer's direction, while not belonging exclusively to the Women's Department, is an event which deserves to be chronicled. The M. A. C. chorus, assisted by Miss Maud Staley, soprano; Mrs. Rachel Frease Green, soprano; Mr. Walter C. Howell, basso; Mr. Edwin H. Douglass, tenor, and Mr. S. T. Schroetter, pianist, gave Hayden's "Creation" to the complete satisfaction of a large audience.

The experiment of evening classes has been tried during the year with

marked success. The Young Woman's Christian Association of Lansing used the gymnasium on Friday evenings of the fall and winter terms, under Miss Avery's instruction. In the spring term a class met in the cooking laboratory on Tuesday and Friday evenings in charge of one of the special students, Miss Lilian Eichbaum, the work being directed by Miss Lyford.

The Dean of the department, having been appointed expert in charge of Household Economics for the Agricultural Colleges' exhibit at the Louisiana Purchase Exposition, has been obliged to give considerable time during the year to that work. She takes this opportunity to acknowledge with thanks the help of the members of the department.

Respectfully submitted,

MAUDE GILCHRIST,
Dean of Women's Department.

Agricultural College, Mich.
June 30, 1904.

REPORT OF THE DEPARTMENT OF BACTERIOLOGY AND HYGIENE.

President J. L. Snyder:

Dear Sir—The College work in bacteriology for the year has been prosperous; at one time all but a dozen of the tables in the spacious new laboratory were in use.

It is a matter of deep concern that we part with such assistance as Mr. Edwards has given through his long period of connection with this department, still it is very commendable on his part to carry into execution what he has had in mind throughout his stay here. We have been cognizant of this and he has kept us informed of his purposes. Through his tactfulness, modesty, patience, and good cheer, we have found not only a companion in scientific labors, an efficient instructor, a responsible assistant, but a man of honest purposes, of sincere endeavor, and of high motives. In leaving us we trust he will meet with even greater success in new fields.

Since bacteriology is a comparatively new study in our curriculum, some have doubted the wisdom of giving it so much importance. Because it is new, this reason would be impertinent in our consideration, for every science has been new in its development. It started in a small way in medical schools, but what would be thought of a medical school without its course in bacteriology at the present time? If this is true of medical schools, it ought to be many times more important in agricultural schools where have to be considered animal diseases and hygiene, bacterial plant diseases, dairy and soil problems, food preservation, and fermentation industries, et cetera. As it is to medicine, so it is to each of these various fields. Thus we find it much more important in agricultural schools than in medical schools.

Because of the apparent ignorance regarding the work, and a dis-

position of some minds to close the doors to new fields of knowledge, I have concluded to give a very brief discussion of the place occupied by bacteriology in the broad field of sciences, inasmuch as I believe it most pertinent in connection with my report upon the new laboratory recently built.

THE STUDY OF BACTERIOLOGY.

This science, as it appears in the work of an agricultural college, may be approached from two points of view; the one, its place in biological studies; the other, its practical application in agricultural and domestic science.

For many years, much discussion has taken place regarding the most logical development of life studies for classes; whether to begin with higher forms, which are perhaps better known to the eye, and work downward to simple forms, or to begin with simple forms and work upward to the higher and more complex forms, has been the mooted question. If it were impossible or even difficult to demonstrate facts concerning the lower living forms, as this was the reason formerly given for avoiding this field, and if the facts known were in any degree limited concerning such life, it is easily understood that this state of affairs might lead to such indefiniteness as to cause more or less confusion and even mistiness in the minds of students; but it is possible to study one-celled structures with ease and accuracy, which was not the case 25 years ago, and to follow these structures throughout their various functions. This granted, it follows that a better understanding may be obtained as a starting point or as a foundation for the examination and systematic study of cells in the aggregate, or, in other words, of complex structures. This is in accordance with the laws of pedagogy, beginning with the simple and leading to the more complex; and it is also more logical, for one can go from the uni-cellular structures to the more complex forms by gradations and with a degree of satisfaction regarding the knowledge acquired. Further, even in the complex forms, the cell is now always considered the unit of study, and bodies made up of millions of cells are studied as if they were simply composites of these individual units. Because of the complexities arising from the combination of so many cells and specialized structures, it may be easily understood that many obstacles will be met in tracing out successfully and without entanglement the various functions which belong to these higher forms.

It is true, courses in biological work attempt the elaboration of this idea, but, in these very biological courses, it will be found that the material studied is usually not of the simplest forms, but parts or cells of the more complex bodies or forms higher up in the scale than those studied in bacteriology. In this subject, only the simplest forms of life are studied. They are almost invariably uni-cellular organisms. Again, if this is true, biological work should begin with bacteriology. In order to illustrate our contention, by a concrete example, let us take the matter of nutrition, to see whether nutritive laws applying to bacterial life are in any way similar to those governing higher forms.

The physiologic acts of nutrition found in bacteria and which may be studied so perfectly in this class of life may be, in large part, compared with the nutritive processes of the human body. Where in nature

can one secure such a wholesome knowledge of enzymic action? With these lower forms, every enzyme known to life may be found, and it may be studied with such exactness in its relations to life that to take it apart from this simple life, usually leads to false conclusions. The manufacture and secretion of enzymes by the cell, the agents which influence these processes,—all factors which in one way or another control them may be studied with a degree of minuteness which cannot be attained by studies in the human body. Osmotic processes in cells can nowhere be followed out with so much satisfaction as with bacterial cells which may be cultivated at will, handled at will, and made to respond to the various agents to which we may see fit to subject them. The adjustment of protoplasm to different conditions, different stimuli, and different nutrients and its possible alterations may be a matter of precise calculation. Protoplasmic activity as manifested in cell metabolism may be investigated and reached with comparative ease whereas in the more complex structures we have to content ourselves with only remote products.

It has been found that the logic of man, which is too frequently employed, cannot in any way account for the nutritive processes of unicellular life. Logic is faulty and very dangerous. For instance, some cells are found dependent upon a living host; others may live upon dead organic matter; and then there are others which are confined for their sustenance entirely to inorganic compounds. We find, too, that the food of these uni-cellular plants may be altered in many ways, and by so doing, the character of the nutritive processes of these living forms is altered. It is fair to suppose, therefore, that with a knowledge of these micro-organisms, far-reaching conclusions would not be drawn in regard to more complex forms without more positive knowledge than we now have at hand. To suppose that different tissues require different elements for their sustenance seems very reasonable to the human mind, but it is not safe to say that these elements are procurable in only one form, or from only one source. Substances may be found to furnish building material and energy in the body, but to just what degree they are capable of doing this is quite another matter. We are led to these conclusions simply from study of single cell life. So it is that many astute workers are not so ready to utter conclusions as is usually the case with those who are less acquainted with such simple life manifestations (and already some workers are basing their work on nutrition upon bacteriological facts). In striving, therefore, for a knowledge of life problems as represented in higher animals or plants, many obstacles are met which cannot be surmounted. Such a point has been reached that when a clue is given workers flock to it, and keep reiterating results until they become so heavy and so massive that to see their simplicity or their pertinency, or to properly value their significance becomes very irksome. In bacteriological work, however, matters are so simplified that the main line of research or thought, or the main line of study may be kept constantly before the mind, and experimental evidence produced, and every bit of energy devoted to it, without any diverting accessories in burdensome quantities.

It may be desirable to recall the general physiological knowledge which has been derived from the study of precipitins, agglutinins, lysins, and anti-toxins. All of these have emanated from bacteriological

investigations, but their bearing is more general and passes, in reality, into the domain of general physiology.

Upon a detailed study of these substances, the student will soon conclude that there is much in their nature which corresponds closely to the nature and functions of higher organisms. The Ehrlich hypothesis, which has been introduced for the purpose of answering, and does answer the phenomena connected with the nature of toxins and anti-toxins, has given a great impetus to the study of the phenomenon of nutrition, and this hypothesis has been adopted by many capable workers.

Because of the close relationship existing between the reactions of anti-toxins and toxins with the cells of the body, and likewise between foods and their reactions, there is every reason to believe that such an hypothesis will eventually lead to such experimental data as may give conclusive evidence concerning the methods of body nutrition.

Besides what we have hinted at in connection with the nutritive processes of the higher organisms, as compared with those simpler forms which are studied in bacteriology, there are other functional operations which could be carried out in further comparisons.

The next standpoint from which bacteriology could be considered is that of application. For this purpose it will be well to divide the matter for discussion into several parts.

HYGIENIC AND MEDICAL BACTERIOLOGY.

Were it possible to draw an outline depicting the conditions which existed 50 years ago in medicine, and by its side another which would illustrate the conditions which are known at present, then we could, in part, appreciate what bacteriology has done for the human family through the medical profession. How many lives were dissipated by the surgery of old cannot be estimated, but asepsis and antisepsis have made it possible to enter almost every part of the body with ease, unless functional operations are interfered with. Confinement has lost much of its dread through the initiative work of Lister and others. In this phase of medicine alone sufficient has been done for motherhood to place this science among the foremost in the providing of fundamental knowledge, for this well illustrates how it dips into the varied aspects of daily life, not as a pure scientific subject, but rather as an applicable fact. In proportion to the knowledge acquired, does it become extremely useful, because an intelligent understanding of it is essential to economic direction.

Again, sanitary science would be ineffective were it not for this science which underlies it. Lives and business have been saved by the practical methods of fighting communicable diseases furnished through this science. This may be easily seen in what has been done for Cuba through the stamping out of yellow fever and what is being undertaken by the U. S. government at Panama to render life secure during the building of the inter-oceanic canal. Note also the common use of black-leg vaccine, employed throughout the west for cattle, and to a considerable extent in Michigan. Vaccines for anthrax and other diseases are to be placed to its credit. Anti-toxins have been found and are utilized to counteract the toxins produced by micro-organisms. A

notable and practical result of this has become familiar to most people in the treatment of diphtheria. Its value is best appreciated by the physician who has made use of diphtheria anti-toxin serum. How far the work may eventually be carried, and how many diseases controlled, no one is able to predict. There is much of the present, as much as in any great science, but its future glows with probabilities and the good it may do for mankind.

No greater value could be adduced for this science than that to be derived from its contributions to the manipulation of water supplies and sewage disposals. Here it has been the means of reducing the mortality of cities from fevers and choleras; in other words, from a high to a low rate of mortality, because it has been the one factor wanting for the devising of controlling agents. A knowledge of micro-organisms has made it possible to create and manage filter beds which are under constant bacteriologic observation. Sewage is also beginning to lose its peculiar significant meaning as related to diseases of various kinds. The future promises unpolluted water supplies and complete sewage destruction with harmless fertilizer production, not only to cities, villages and populated centers, but to rural homes as well.

DAIRY BACTERIOLOGY.

The relation which bacteriology holds to medicine is, in many respects, the same as it holds to dairying. It is possible to designate the fermentations occurring in milk as diseases to which milk is heir. The transmission of disease by means of milk might more strictly belong to hygienic bacteriology, yet it also has an important place in this division of the science; and no little importance can be attached to it, for, to a great extent, the welfare of the race is dependent upon a pure milk supply—a milk free from the micro-organisms which are capable of initiating disease processes and producing toxic action. It is desirable, therefore, that an understanding should be had of the avenues by which germs reach the milk and are conveyed by it, as such knowledge will contribute much to the restriction of milk-borne diseases.

Again, although there are many micro-organisms capable of causing changes in milk in the udder and outside, they cannot be regarded as dangerous from a health standpoint, but, on the other hand, they cause mischief through their ability to set up various obnoxious fermentations. Every germ seems to have a specific action upon milk; consequently, possibilities of changes in milk are indefinite. In these fermentaions are found the various troubles arising with milk consumers and those who would manufacture dairy products. It is true that without these fermentations, and also without the possibility of transmission of disease through milk, the bacteriologist would find little opportunity in milk for investigation and work. But, with the conditions as we find them, and also with some commercial fermented products of milk, the field of action becomes exceedingly broad; in fact, so broad that many bacteriologists do not attempt to pass its boundaries. To ward off or control the fermentations or off-conditions of milk; to check the transmission of diseases through milk; to encourage and foster those changes which will eventually give rise to satisfactory products; and to study the technique of germ manipulation are, in general, the broad divisions of

labor for the dairy bacteriologist. More particularly, the health of the cow, the condition of the milk in the udder, the diseases transmitted by the milker, the drainage and ventilation of the stable, the dust arising from stable, bedding, and feeding, the grooming of the cow, the cleanliness of the milker and milking utensils, the sterilization of the milk utensils, the aeration of the milk, the cooling of the milk, the quality of the water, the pasteurization of milk and cream, the ripening of milk and cream and cheese, the manufacture of starters, and many other important matters of the dairy find their rationale in germ life, in the science of bacteriology, which is essential to dairy work. It is, therefore, safe to say that he who has the principles of bacteriology at his finger tips is best fitted to be a successful milkman or dairyman. To conduct dairy operations, one must be acquainted with the reasons of the different steps. These, in large part, are found in knowing micro-organisms, in being acquainted with the habits and the conditions under which they grow, the methods of handling them and in utilizing them in the manufacture of certain products. It is quite commonly the case that such knowledge comes by rule of thumb, or otherwise, and not in an intelligible form with a definite scientific basis. It is necessary that the guiding principles be known in order to interpret and apply the knowledge to the best advantage.

SOIL BACTERIOLOGY.

Chemistry tells us about some of the elements of the soil; physics tells us of its physical structure and its dynamic forces; but it remains for bacteriology to consider those agents which produce those peculiar changes in soil, by which the latent forces are rendered active; those agents which create food substances for plants, and, in short, those agents which make soil fertility. Bacteriology stands for the changes; chemistry measures the changes; and physics fosters the changes which we find taking place through the fermentations wrought by the activity of micro-organisms. What does soil bacteriology mean, accordingly?

We are familiar with the knowledge furnished us by geologists that soil usually results from rock disintegration, and that its fertility is measured by the amount of those constituents required for plant growth or of organic matter which it contains and the possibility of a dissolution of this organic matter. Through the instrumentality of micro-organisms, through chemical interchange, and through physical treatment, we find soil made ready for plant growth. There are those who believe that no unimportant part of the work is due to microbian action, This conclusion is reached from a knowledge of fermentations in general, and of those taking place in the soil, for practically all organic reduction must be attributed to micro-organisms; practically all fermentations of whatever nature also go to this source; and inasmuch as we know that organic matter is not suitable for plant growth and that much inorganic matter must be made soluble, it follows that plants are dependent for their food preparation from organic substances and from insoluble inorganic substances by the growth and development of microbes. They reduce the more complex substances to simpler forms, and frequently render soluble, insoluble inorganic substances in which the plants find food. So it is that much of the manurial value of those materials which are used upon lands is derived through living forms

and thus it is, too, that many of the economic manipulations are based upon the habits of this life. The idiosyncrasies of germ life must be studied if we are to gain in our knowledge of the practical management of organic and inorganic substances for land fertilizers.

If a fertilizer is of such a nature as to be thoroughly utilizable by plants, germs may be of little use, but usually such fertilizers are more expensive and are not considered so good, perhaps because germs can feed plants steadily with such quantities as are derived by their slow, constant action, while a single addition of fertilizer does not fulfill the mission but gluts for a time, then is largely washed away.

The soil possesses much energy for plant growth which is latent. In other words, in almost every soil there are constituents in sufficient quantities to enable plants to grow. Even when worn out, soils are frequently found to contain sufficient nitrogen, potash, phosphoric acid and other ingredients. Under such conditions, those constituents which should be utilized by the plants are tied up in such a manner as to be useless. They must be rendered available to the plant if the soil is to recover its worth. To accomplish this, the agents of change must be present, must be properly fed, must be properly treated when the inert chemical substances will respond to the living forces by production of solvents which will burst asunder the apparently strong cords of chemical equilibrium. In other words, these life forces have the power of introducing life into chemical death. Physical treatment assists bacterial activities, likewise fosters certain restorative conditions, all of which contribute to the welfare of plant life. Work which has already been done not only establishes the present of soil bacteriology, but indicates experimentally a brilliant future for this branch of the science. It points to great possibilities in creating energy out of apparently dormant material. In proportion to the amount of energy that is introduced into the life activities of the soil by certain physical management, in that proportion will certain chemical changes be initiated and continued; or, in that proportion will certain energy pass into chemical activity.

PLANT BACTERIOLOGY.

Under this heading may be pertinently considered the bacterial diseases of plants, bacterial vegetable decay, and nitrogen abstraction and assimilation from the air by certain bacterial nodular growths upon roots. In the matter of bacterial plant diseases, there is a field which has been as thoroughly worked in this country as anywhere, and which has given to agriculturists an insight into certain drastic communicable diseases that hitherto it was not our privilege to enjoy. Through the arduous labors of Smith, many bacterial plant diseases have been opened for study and this knowledge has been utilized in their control. Whether it is going to be feasible to consider the immunization of species or the introduction of harder types or the treatment of diseases after they are already started, remains to be determined in the future. Some work already suggests future development along these lines. At the present time there is not much to be said other than the fact that these diseases exist; that they are caused by bacterial forms; and that their treatment seems to be quite uniform.

Plant and vegetable decay taken in conjunction with fungus agents

open into another line of bacterial studies, which doubtless will give rich harvests. In fact, there is much to be placed to the credit of this line of work at the present time.

No field, however, offers as much promise and has given such available information as that which is to be gained from a study of the tubercules found upon the roots of legumes. It is of great importance that we know the functions of these tubercles which are filled with bacteria, and, further, that their instrumentality in abstracting nitrogen from the air be understood. Chemists ten years ago were constantly teaching that the nitrogen would soon be exhausted in the soil and that there were very few agents which contributed any, and what these agents did contribute was in such small quantities as to be of little use. We looked forward to nitrogen starvation. This is a good illustration of the errors which creep into conclusions drawn from a study of chemical elements and compounds without a study of those living agents which are constantly manipulating them. Already the practical application of this fact that tubercles will form on certain plants and feed them with nitrogen has become extensive, and we look forward to a wider application as the precision of knowledge grows and as, also, we become more familiar with the scientific facts which govern such micro-organisms. Eighty per cent of the air is nitrogen. There is, therefore, a large fund of nitrogen in the air from which to draw, and if it can be used for the fertilization of plants, it can, consequently, be used for animal growth, and life will be continued much longer than we supposed 20 years ago.

FERMENTATION BACTERIOLOGY.

This is a branch of bacteriology which has been worked thoroughly for the past 30 years. The work of Pasteur and Hansen is already seen in many of the fermentation industries, and it is generally conceded by these industries that the experiments of these men may be considered invaluable in the development of uniform fermentations, in the control of off-fermentations, and in the selection of those species which give the greatest yield and the best product. At present, there are many laboratories which devote their entire attention to the physiology and morphology of fermentations, and these laboratories are utilized in preparing men to enter into the service of these fermentation industries for the purpose of studying the best methods of procedure and also for the purpose of improving the fermentations. It is safe to say, especially as it is founded upon actual statistics, that millions of dollars have been saved annually to each of several countries through their power to produce uniform results and to eliminate possible abnormal fermentations from their manufacture.

In many of these fermentation industries, so careful are they to hold to the correct methods and correct species of micro-organisms, that the manufacturing plant becomes a veritable bacteriological laboratory. In this country, many farmers have great concern over the production of vinegar. Although we have been brought up largely in the belief that vinegar will always come from cider, any one familiar with the industry at large, has observed the fact that thousands of dollars of loss occur yearly through ignorance of the processes involved. If it were possible to acquaint farmers with the nature of the fermentation

and the micro-organisms involved, there is no doubt that he would be able to save himself large losses in this respect.

Farther than this, the preservation of food is involved in the study of bacteriology, and this feature of the science is represented in the canning industry, in the evaporating and desiccating industries, and in those industries which attempt to preserve foods of various kinds by means of sugar, salt, and the commonly known preservatives.

On the one hand, therefore, we aim to further certain kinds of fermentations which result in certain fermented products; on the other, we try to check fermentation that we may preserve fruits, vegetables, milk, et cetera.

In this very brief resume, and very incomplete discussion, we have hinted at such portions of the field involved as may simply illustrate some phases of the science. We may justly conclude that bacteriology is a science, fundamental in its position, exceedingly broad in its scope, very practical in its application and constant in its daily use. It is the basis of sanitation; of preventive medicine; of septic and antiseptic surgery; of infectious disease; of dairying, with its various fermentations, its commercial products, and its milk-born diseases; of soil changes of fermentations which are, doubtless, far more extensive than those which we find in milk; of nitrogen assimilation from the air, with its consequent leguminous growth; of food preservation; and of other lines of industry,—in short, it is an economic study with varied aspects. If it were not for this economic side, doubtless little attention would be given to the biological side, but, inasmuch as so many problems of great importance rest upon the idiosyncrasies of micro-organisms, the biological significance has become greatly and necessarily pronounced and it will doubtless eventually lead to the extension of biological knowledge in the higher-life world. From this standpoint, this science, which has opened new fields in chemistry, physiology, and physics, merits position and space which should be accorded it in biological studies, and these should be fundamental and initial. In economic work, it spreads into nearly every field in which life is at all involved.

Emphasis will be given to what has already been said if we quote the words of Dr. Vaughan, of the University of Michigan, who, in his discussion of "The Value of Scientific Research to the State," says, in part:

"This same science of bacteriology has enabled us not only to limit the spread of the infectious diseases, but it has given us the most brilliant results ever attained in the cure of disease. It has largely robbed diphtheria of its horrors and has reduced the mortality from this disease from over 50 per cent to less than five per cent in cases in which antitoxin is used immediately on the appearance of the disease. This is a triumph in curative medicine which the most sanguine and visionary man of even 10 years ago would scarcely have expected. The same science has given us a means of combatting that rare but distressing disease known as hydrophobia, and of preventing the same. Who can say that the world has not been benefited by the labors of the pioneers in bacteriology? Who can overestimate the discoveries of Pollender and Davaine, which to their contemporaries seemed to be at most of only trifling importance? Who can foretell the benefits that may come to mankind from what appears to be a trifling scientific discovery?

"The bacteriologist has not confined his labors to the study of those micro-organisms which cause disease, but he has gone farther and has shown that some of these minute forms of life which we call germs are capable of rendering great service to mankind. Only a few years ago it was believed by many scientists that the amount of combined nitrogen in the world is constantly decreasing, and that neither plants nor animals are capable of utilizing the free nitrogen in the air. It was therefore supposed to be a necessary conclusion that life on this planet must cease as soon as all the combined nitrogen is used up. It was stated that the explosion of every ounce of gunpowder, whether the projectile which it carried struck a living object or not, carried death with it, inasmuch as it lessened the sum total of combined nitrogen in existence. The bacteriologist by his investigations has shown that this state of affairs is not so bad as was once believed. He has demonstrated that there are certain micro-organisms growing on the roots of certain plants, and that by the combined action of the germ and the plant free nitrogen may be taken from the air and utilized in building up plant tissue or in other words, that it may be changed from the free to the combined form, and when thus changed, it may subsequently be used for food by either plants or animals. This is what is known as the process or function of fixing nitrogen, and it depends upon the combined action between certain germs and leguminous plants. About 20 years ago it was quite conclusively shown that peas, beans, and other legumes when grown in a soil wholly free from nitrogen were capable of constructing nitrogenous compounds and building up nitrogenous plant tissue, while the only source of the nitrogen thus utilized was that existing free in the atmosphere. At first this view was believed to be founded upon faulty observations, but thorough experimentation has shown that the statement made above is a fact. Then men set about to ascertain the conditions under which plants, and especially leguminous plants are able to utilize the free nitrogen of the atmosphere. These experiments were conducted by skilled botanists in various parts of the world, and now after 20 years of these labors it can be positively stated that the manner in which leguminous plants convert nitrogen into compounds has been discovered. If the roots of a leguminous plant be studied, they will be found to be dotted with tiny nodules, which are known to the botanist as tubercles, but which, however, have no relation to the pathological conditions known to the medical man under the same name. These tubercles or swellings on the roots of the pea vine vary markedly in size. They may be so small that they are barely discernible to the naked eye, and in some instances they have a diameter of one-sixth of an inch or more. Of course the existence of these nodules on the roots of leguminous plants had long been known, but their function was not understood. It was generally believed that their presence indicated a diseased condition, but it was found that the plants on the roots of which they developed most abundantly thrived most vigorously. I shall not attempt before this audience, in which there are many who know more about this subject than I do, to go into detail concerning the relation of these tubercles to the fixation of nitrogen by leguminous plants. Suffice it to say that experimentation has shown that these nodules do not form on the roots of plants grown in sterilized soils, and that under the same conditions

such plants take up no nitrogen from the atmosphere. Next it was found that if leguminous seeds were planted in sterilized soil, devoid of nitrogenous food, and were watered with an infusion of sterilized soil, they manifested two characteristic and peculiar stages of growth. At first the peas sprouted readily and grew vigorously for a very short time, when growth ceased. This period, which the botanist now designates as the stage of nitrogen hunger, was reached as soon as the plant had used up all the combined nitrogen in the seed. If at this stage some of the plants were watered only with sterilized earth infusion, they did not recover, but continued to waste away and finally died, while those watered with non-sterilized soil infusions soon began to take on a vigorous growth, eventually developed into well nourished plants, and produced an abundant yield. Upon examining the roots of these two sets of plants, it was found that those watered with sterilized soil infusions showed no tubercles or nodules, while those watered with non-sterilized soil infusions carried these tubercles. These experiments quite naturally suggested that the tubercles were formed by the agency of bacteria, and microscopic and cultural studies confirmed this supposition. Soon the characteristic micro-organisms in these tubercles were obtained in artificial culture media and their casual relation to the tubercles was proved by direct inoculation experiments. Moreover, peas were planted in sterilized soils, and watered with these cultures. When this was done it was found that tubercles formed abundantly on the roots of the plants, which, on account of their ability to fix nitrogen, grew vigorously and produced abundant crops. Additional studies have shown that these bacteria, which are quite widely distributed in the soil, pass into the roots, forming the swelling or tubercle at the place of entrance, penetrate the woody tissue in the form of delicate filaments, and produce a mucilaginous substance which permeates the tissues of the plant. There has been some discussion as to whether it is the bacteria or the plant which fixes the nitrogen, but the only conclusion which can be justified by the experiments that have already been made is that both of these organisms are essential, both the germ and the leguminous plant are necessary, and they must act together in order to take free nitrogen from the air and combine it into the tissues of the plant. I should state that some experiments indicate that there is a certain amount of nitrogen fixation in the green parts of many plants, but this is so very small compared with the large quantities fixed by the combined action of leguminous plants and the bacteria that it cannot be considered to be of any special importance. In this way it will be seen that there is an association between the plant and the micro-organism which is mutually beneficial to the two, and which enables the two working together to take free nitrogen from the atmosphere and build it up into tissue which can be subsequently utilized for feeding other plants and even nourishing animals as well. Some experiments indicate that there are different species of the tubercle organism, and that it is necessary in order to get the best results to bring together the special legume and the special tubercle bacillus which best work together.

"It will be seen from this that bacteriology has been a benefit to the world not only by decreasing sickness and lessening the death rate, but also by pointing out to the farmer a way by which he can utilize

the inexhaustible stores of free nitrogen in the atmosphere as a fertilizer for his soil. Moreover, it has placed within the hands of man the means by which under intelligent direction the abundance and vigor of life in this world can be increased. It shows us how it may be possible for the arid sandy plain to be converted into a rich field, and how waste places may be fertilized and made to yield abundant food for plant and animal."

The author's conception of "The Science of Bacteriology" is based upon certain economical and technical considerations which are comprehensive and would gather within the scope of this science the vast fields of microbian diseases of animals and plants and fermentations as found in the dairy, in the soil, in foods and drinks, in various industries, and elsewhere, in fact, in the broad realm just discussed in the foregoing pages. The life designated by the above scheme is usually limited to those molds which figure in fermentation changes, as conceived industrially, to yeasts which are employed in industrial fermentations and may be cultivated advantageously or otherwise, to bacteria which represent the largest and most important class, and to those forms, protozoal perhaps, which are now found as the cause of numerous infectious diseases.

A most general outline of bacteriology may be added not only for the purpose of conveying an idea of its range as understood by us, but also of reviewing systematically some of the subject matter treated in the science. Such an outline is demanded in this discussion.

A. MORPHOLOGIC AND CULTURAL.

I. Morphology and Development.
  1. Gross anatomy.
    a. Form.
    b. Size.
    c. Arrangement or grouping.
    d. Multiplication.
    e. Involution and variability.
  2. Histology of cell.
    a. Wall or outer membrane.
    b. Protoplasm.
    c. Flagella and motion.
    d. Spores.
  3. Classification and their basic features.

II. Cultural Significance.
  1. Media.
    a. For morphologic and developmental studies.
    b. For cultural effects.
  2. Colonies.
  3. Cultural features.

III. Staining Values.
  1. Demonstrations of parts of cell.
  2. Identification of species.
  3. Differentiation of species.

IV. Determination of Micro-Organisms.
1. Methods employed.
2. Differential characteristics.

B. PHYSIOLOGIC.

I. Cell Studies.
1. Composition of cell contents.
2. Composition of cell wall.
3. Pigment formation.
4. Light production.
5. Heat production.
6. Absorption of assimilation of foreign bodies.
7. Chemotaxis.
8. Plasmolysis.

II. Studies in
1. Elements required in growth of micro-organisms.
2. Respiration.
3. Nutrition.
4. Moisture.
5. Cultivation temperatures.
6. Conditions of media.
7. Physiologic test-media.
8. Identification and determination by means of
   a. Cultural physiologic methods.
   b. Chemic tests.
   c. Physical tests.

III. Studies in
1. Symbiosis.
2. Metabiosis.
3. Antibiosis.

IV. Common Fermentative Changes Wrought by Micro-organisms.
1. Studies in enzymes.
   a. Kinds.
   b. Actions and materials fermented.
   c. Conditions under which they act.
      Temperature.
      Concentration of solutions.
      Reaction of material.
      Extent of accumulated products.
      Et cetera.
2. Products manufactured by fermentation.
   a. Necessary conditions of production.
   b. Most favorable conditions of production.
   c. Methods of determination.
      Qualitative.
      Quantitative.
   d. Constancy and variability of products.
   e. Gradation in fermentation changes.
      Intermediate products.
      Ultimate products.

V. Products Significant Through the Intermediation of a Host.
 1. Agglutinins.
 2. Precipitins.
 3. Lysins.
 4. Toxins.
 5. Anti-toxins.

VI. Influencing Agents.
 1. Light.
  Direct.
  Diffuse.
  Special.
 2. Heat.
  Dry.
  Moist.
  Under pressure.
 3. Cold.
 4. Chemicals.
 5. Filtration.
 6. Mechanical pressure.
 7. Mechanical agitation.
 8. Electricity.
 9. Dessication.

C. HYGIENIC.

I. Communicable Diseases of
 1. Man and animals.
  a. Causal agent or micro-organism.
  b. History of micro-organism.
  c. Tenacity or persistency of micro-organism.
  d. Avenues of dissemination and infection.
  e. Distribution of micro-organism in body.
  f. Management of disease.
  g. Prevention of disease.
  h. Care of dead from communicable diseases.

II. Surgical Significance.
 1. Wounds.
 2. Abscesses.
 3. Septicemia.
 4. Malignant growths.
 5. Operations.

III. Susceptibility and Immunity.
 1. Natural.
  a. Race.
  b. Species.
  c. Age.
  d. Individual idiosyncrasies.
  e. Body components.

2. Acquired.
    a. Devitalization.
    b. Hereditary predisposition.
    c. One attack of disease.
    d. Vaccines.

IV. Serum Therapy—Bacterial Therapeutics.
1. Diagnostic agents.
2. Remedial agents.

V. Disinfection and Antiseptics.
1. Agents emoplyed.
2. Determination of values.
3. Methods.

VI. Sanitary Studies.
1. Water analysis.
    a. Methods.
    b. Interpretation of results.
2. Water contamination and filtration.
3. Sewage analysis.
    a. Methods of.
    b. Determination of values of micro-organisms.
4. Sewage destruction beds and filtration.
    a. Aerobic.
    b. Anaerobic.
    c. Products.
5. Ventilation.
    a. Currents as means of dissemination.
    b. Filtration of air.
    c. Germ content of air.
    d. Methods of analysis.
6. Foods.
    a. Poisonous.
    b. Infected.

D. DAIRY.

I. Milk Supply.
1. Communicable diseases conveyed through milk.
    a. Kinds of micro-organisms.
    b. Avenues of transmission.
    c. Prevention.
2. Environments of animal and conditions of milking.
    a. Stabling.
    b. Feeding.
    c. Milker.
    d. Utensils.
3. Bacterial content of milk in udder.
    a. Non-pathogenic micro-organisms.
    b. Pathogenic micro-organisms.
    c. Conditions of growth in udder.
    d. Special fermentations (garget et cet.).

4. Bacterial action on constituents of milk.
   a. Proteins.
   b. Butter fat.
   c. Lactose.
   d. Mineral constituents.
5. Analysis of air of stables.
   a. Before cleaning.
   b. Immediately after cleaning.
   c. Before feeding.
   d. Immediately after feeding.
   e. Anaylsis of out-door air.
6. Determination of value of straining.
7. Determination of value of aeration.
8. Determination of value of cooling.
   a. Simple cooling.
   b. Cooling and keeping cool.
   c. Cooling and warming, then cooling.
9. Cleansing of utensils.
   a. Methods and their value.
   b. Water analysis.

II. Pigment in Milk and Cheese.
1. Kinds.
   a. Red.
   b. Blue.
   c. Black, et cetera.
2. Character.
3. Condition of formation.
4. Control.

III. Fermentations in Milk, Butter and Cheese.
1. Kinds.
   a. Lactic.
   b. Butyric.
   c. Alcoholic.
   d. Gaseous.
   e. Peptic.
   f. Rennet.
   g. Ropy.
   h. Soapy.
   i. Taints.
      Bitter flavor, Barn-yard, Tallowy, et cetera.
   j. Special.
      Kephir, Koumiss, Matzoon, et cetera.
2. Micro-organism involved.
   a. Its life history.
   b. Alteration.
3. Nature of fermentation.
4. Constituents acted upon.
5. Products of.
6. Conditions influencing it.
7. Controlled or fostered.

IV. Pasteurization and sterilization.
1. Determination of significance of each.
2. Methods employed.
3. Practical utilization.

V. Starters.
1. Natural.
a. Sour milk.
b. Cream.
c. Buttermilk.
d. Others.
2. Artificial.
a. Pure cultures.
b. Mixed cultures.
3. Value determined.
4. Preparation.
5. Employment.
6. Constancy.
7. Influencing conditions.
8. Facts governing amounts to employ.

VI. Butter.
1. Micro-organisms present.
2. Micro-organisms compared with those of milk.
3. Conditions of life changed.
4. Decomposition.
5. Preservation.
6. Significance of casein and buttermilk in butter.

VII. Cheese.
1. Kinds of micro-organisms employed in different cheeses.
2. The study of micro-organisms in the ripening process.
3. Influence of micro-organisms on aroma.
4. Keeping values.

VIII. Preservatives.

IX. Disinfectants utilized.

E. SOIL.

I. The Making of Soil.
1. Bacteria in soil.
a. Number at different depths and in different soils.
b. Kinds at different depths and in different soils.
c. Character of micro-organisms found.
2. Rock disintegration.
3. Decomposition of organic material.
a. Celluloses.
b. Starches and sugars.
c. Proteins.
d. Et cetera.
4. Action of iron and sulphur bacteria.

II. Ammonification.

III. Nitrification—The nitroso and nitro processes.
  1. Conditions influencing.
    a. Physical.
    b. Reaction.
    c. Temperature.
    d. Supply of oxygen.
    e. Amount of organic matter present.
    f. Moisture.

IV. Denitrification.
  1. Factors influencing the loss of nitrogen.

V. Action of Micro-Organisms upon the Mineral Constituents of the Soil.

VI. Sewage Disposal Studies. (See "Sanitary Studies" under "Hygienic Bacteriology.")

F. PLANT.

I. Nitrogen Accumulators.
  1. Micro-organism involved.
  2. Cultural characteristics.
  3. Formation of nodules.
  4. Character of nodules.
  5. Conditions under which they form.
  6. Determination of nitrogen accumulations.
  7. Significance of nodules.

II. Bacterial Diseases.
  1. Kinds.
  2. Micro-organisms found as causal agents.
  3. Cultural characteristics.
  4. Resistance of micro-organisms.
  5. Persistency.
  6. Methods of treatment.
  7. Pathology.

III. Bacterial Decomposition of Fruits, Vegetables and Other Plant Substances.
  1. Nature of decomposition.
  2. Micro-organism studies.
  3. Conditions favoring development.
  4. Control.
  5. Structural changes.

G. FERMENTATION.

I. Factors Controlling Fermentations.
  1. Presence of micro-organism.
  2. Purity of culture.
  3. Vigor of cell.
  4. Character of fermentable material.
  5. Air supply.
  6. Reaction of medium.
  7. Temperature.
  8. Concentration of fermentation solutions.

II. The Production of Enzymes by Micro-Organisms.
  1. Formation of enzyme in cell.
  2. Its secretion by the cell.
  3. Determinative methods for study.
  4. Environmental influences.

III. The Fermentations.
  General.
    1. The enzymes.
      a. Cytases.
      b. Diastases.
      c. Invertases.
      d. Glucases.
      e. Inulases.
      f. Trehalases.
      g. Raffinases.
      h. Lactases, et cetera.
      i. Proteolytic.
        Peptic like.
        Tryptic like.
        Bacteriolytic, et cetera.
      j. Lipases.
      k. Clotting.
        Rennin.
        Thrombase.
      l. Et cetera.
    2. Materials acted upon.
      a. Celluloses.
      b. Starches.
      c. Sugars.
      d. Fats.
      e. Proteins.
      f. Et cetera.
    3. Products resulting. (To be continued with 1 and 2.)

Special.

1. Alcoholic.
    - a. Beer and distilled liquors.
    - b. Wine.
    - c. Cider.
    - d. Ginger beer.
    - e. Fruit juices.
    - f. Koumiss, et cetera.
3. Acetic acid.
    - a. Vinegar.
    - b. Mashes.
    - c. Foods, et cetera.
3. Lactic acid.
    - a. Milk.
    - b. Mashes.
    - c. Foods, et cetera.
4. Butyric acid.
    - a. Milk.
    - b. Mashes.
    - c. Foods, et cetera.
5. Ammoniacal.
    - a. Urea.
    - b. Organic matter of soil.
    - c. Proteins.
    - d. Et cetera.
6. Putrefactive.
    - a. Ptomains.
    - b. Leucomains.
    - c. Acids.
    - d. Alcohols.
    - e. Gases.
    - f. Ammonia derivatives.
    - g. Others.
7. Nitrification.
8. Denitrification.
9. Ammonification.

H. FOOD AND DRINK PRESERVATION.

I. Preservation of Foods.
1. Freezing.
2. Cold storage chambers.
3. Salting.
4. Drying or evaporating or concentrating.
5. Smoking.
6. Corning.
7. Canning.
8. Chemic preservatives or antiseptics.
9. Preserving.

II. Preservation of Drinks.
 1. Pasteurizing and sealing.
 2. Cold storage.
 3. Chemic preservatives.
 4. Filtration.

THE LABORATORY.

With the above comprehensive view of bacteriology in mind,—such a view as may be found typically represented in a large number of laboratories in the world—the plans for a new laboratory were undertaken. Two distinct objects, primary in all of our undertakings, and fundamental to the growth of this science, should be kept in mind in considering these plans; the one, research, as represented as a division of the experiment station, and which is so full of promise for the future; the other, class work, which by means of disseminating knowledge which we already have at hand is essential to progress in a science.

As the needs of this institution were surveyed, the conclusion reached indicated that each purpose demanded about equal attention. Work, as we find it in an agricultural college, must not only be purely scientific but must also pass to an issue and application; otherwise it fails of the mark. Therefore, in order to carry out all of our scientific endeavors to a point where they can be taken up by those who deal in the practical phases of agriculture, it became evident that rooms or facilities must be provided for the study of communicable diseases, of bacterial plant diseases, soil problems, dairying, fermentation,—in short, any bacterial problem known to agriculture or domestic science. In erecting a building that shall include this broad scope, a stable is necessary, a small greenhouse for bacterial plant and soil studies, a soil room for soil storage and filter paraphernalia, a dairy room, a temperature room, and, in short, rooms where the science may be applied to actual problems which are, in one way or another, connected with the practical workings of the farm or of the household. Accordingly, it will be seen that the range of the work is vast; consequently, in order to make the science useful and valuable, the laboratory must be adapted to meet the demands which the farmer or the housekeeper makes upon it.

It should not be necessary that the plans of the laboratory be discussed in detail, for the illustrations following this report will clearly show what each room stands for and will suggest possible uses. Any one who may review these plans critically should bear in mind that it is impossible, in erecting a laboratory, to have everything as he would desire it, simply because there are so many conflicting ideas, and often, if one idea predominates, another must be eliminated. For instance, it is impossible to make all of the laboratory rooms face the north and east, however desirable.

A general description of the laboratory may help to convey a fullness to the meaning of the photographs and clear up points which otherwise would be indistinct.

The building is made of brick, the outer walls having a two-inch air space, primarily to arrest moisture, heat, and cold. Many of the inner

partitions are made of brick. These afford strength to the building, and also partition walls with a brick facing, which is highly desirable. They are faced with sand brick, the seams are well flushed, and the entire surface painted over. Where it was impossible to secure brick partitions, they are made of studding, lath, and adamant, the surface of which is also painted.

The interior wood finish is of southern pine; the floors are of hard maple, and the ceilings of steel.

The lighting of the building is very satisfactory, and, inasmuch as the large laboratories are made to face the north and east, it makes it possible to carry on work without interference from the direct rays of the sun.

The floors of the basement and stable are of cement, but otherwise these rooms are finished as the first and second stories of the laboratory.

The sinks, the bottoms of the hoods, and two tables are of Alberene stone. The supports for tables and hoods are of iron piping.

The building is well equipped with gas, hot and cold water, steam, and air which is now used in conjunction with the gas.

A word may be said in regard to the temperature rooms, because the longer we are in the building, the more valuable they become. The floors of these temperature rooms and the ceilings, are of cement. Each of the rooms opens into a large shaft by means of a glazed surface, and this shaft passes from the basement out beyond the roof of the building. If, in any way, an explosion occurs, which is not too forceful, we trust that the glass will be shattered and a vent furnished by means of the shaft. These rooms have iron doors, and open into outer rooms by means of small ante-rooms, which are closed by iron doors. If fire occurs, within, it is thought that it will be held within by these iron doors. We further try to avoid fire by using only one burner within each room. If this goes out, there will be no light within to cause an explosion, for all of the lighting is by means of electricity. We have already found during the winter months, when the steam is on the building, that, although these rooms were not heated in any way, the temperature was practically constant, varying only one or two degrees over a range of several days. During the whole winter season, taking into consideration the times when the steam was turned off the building for one purpose or another, the maximum temperature limits of these rooms were within 19° and 24° C. We are very much pleased with the success of this innovation. The idea was borrowed, however, from the laboratory of Dr. Moore, of Cornell, being modified to meet the requirements necessitated by the construction of several temperature rooms.

Respectfully submitted,

C. E. MARSHALL,

Professor of Bacteriology and Hygiene.

Agricultural College, Mich.

June 30, 1904.

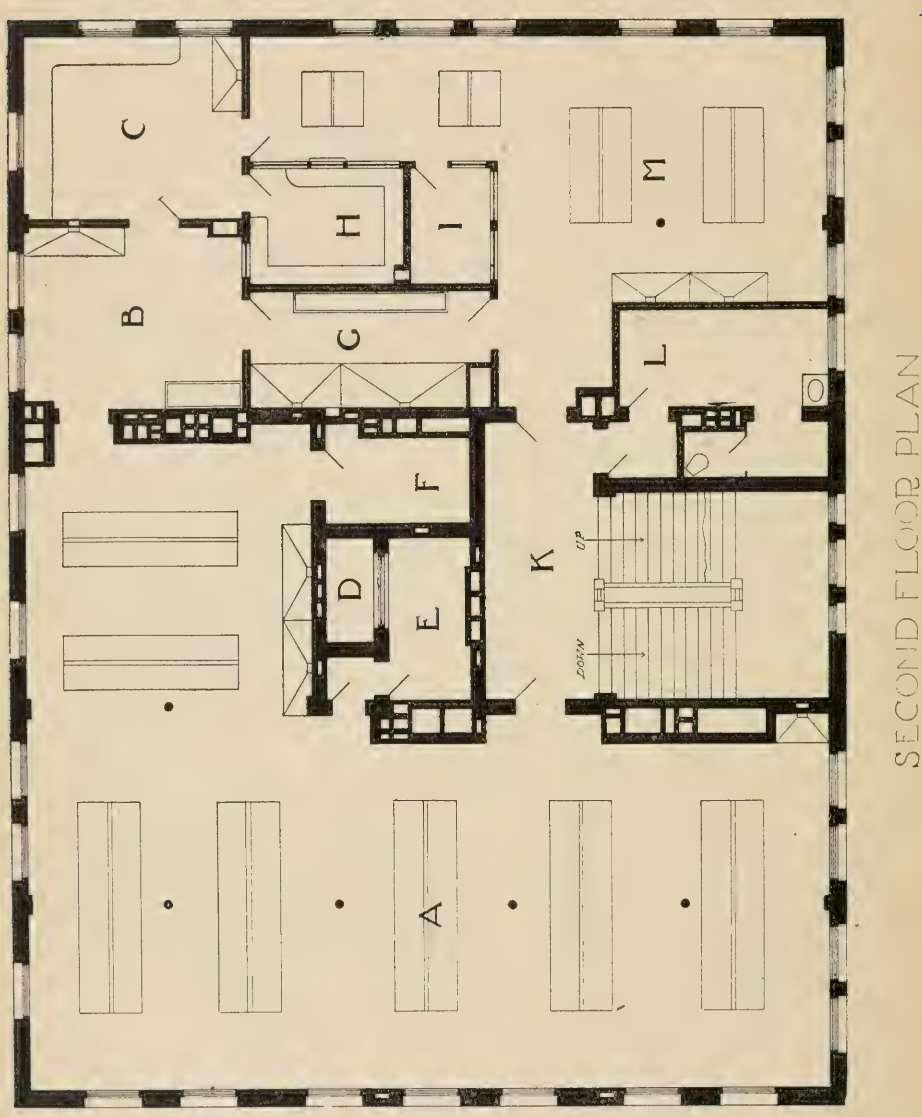


FIGURE I.

A represents large laboratory room for students–52 tables, M small laboratory room for students–12 tables, B testing room for students, C Instructors' room, G steam sterilizing room, H store room, I weighing room, E temperature room, F culturre room, D shaft rising above building, K hallway, L ladies' retiring room.

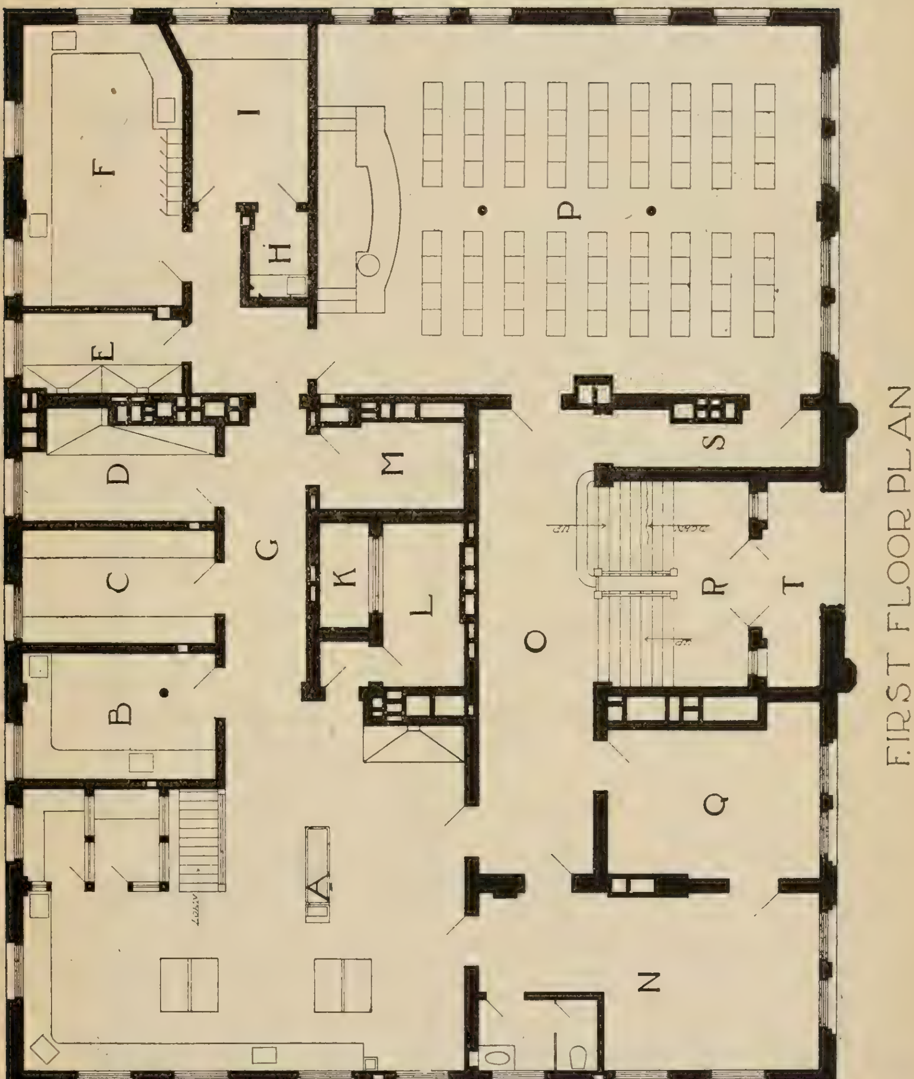


FIGURE II.

A represents experiment station laboratory. N office, Q library, B assistant's room, C store room, D steam sterilizing room, E hood room, F seminary room for research, I photographic room, H dark room, P lecture room, M culture room, L temperature room, O hallway, K shaft rising above building, G passage way.

FIGURE III.

A represents gas pump room, C room for study of fermentation gases. D room for sterilization etc., E & G rooms for gas disinfection and testing, F wash room, H applied dairy room, K glass blowing and other operations, M applied class work, X room for research in soil, Y soil room for soil storage, filters, etc., Z green house, M N O P Q R temperature rooms, L passage ways, V toilet room.

FIGURE V.—FRONT VIEW OF LABORATORY. West side.

FIGURE VI.—SOUTH VIEW OF LABORATORY.

FIGURE VII.—NORTH VIEW OF LABORATORY.

FIGURE VIII.—LECTURE ROOM. First floor.

FIGURE IX.—CLASS LABORATORY. Second floor.

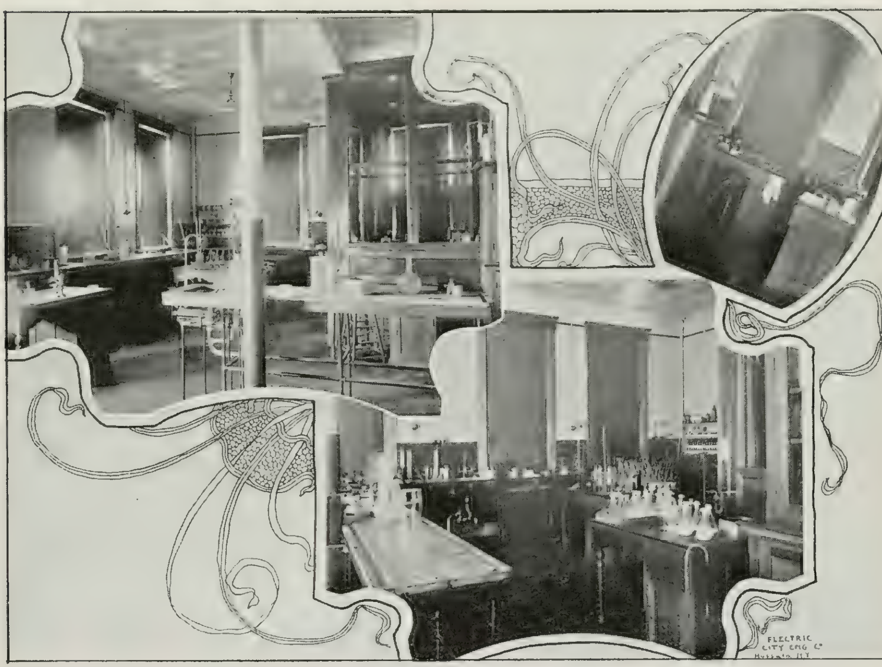


FIGURE X.—EXPERIMENT STATION LABORATORY. First floor.

FIGURE XI.--INTERIOR STABLE. Court.

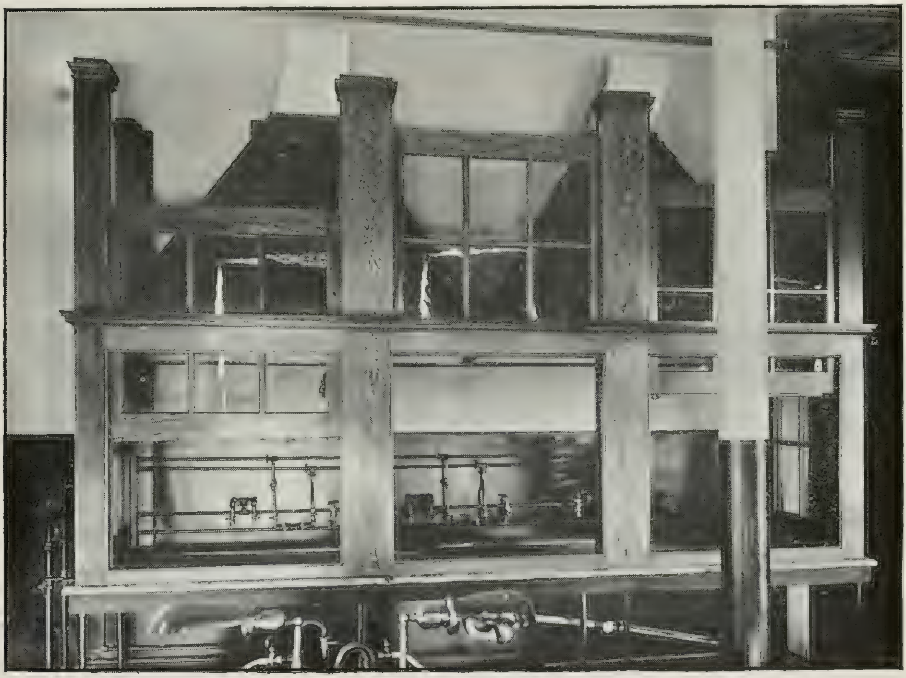


FIGURE XII.—HOOD

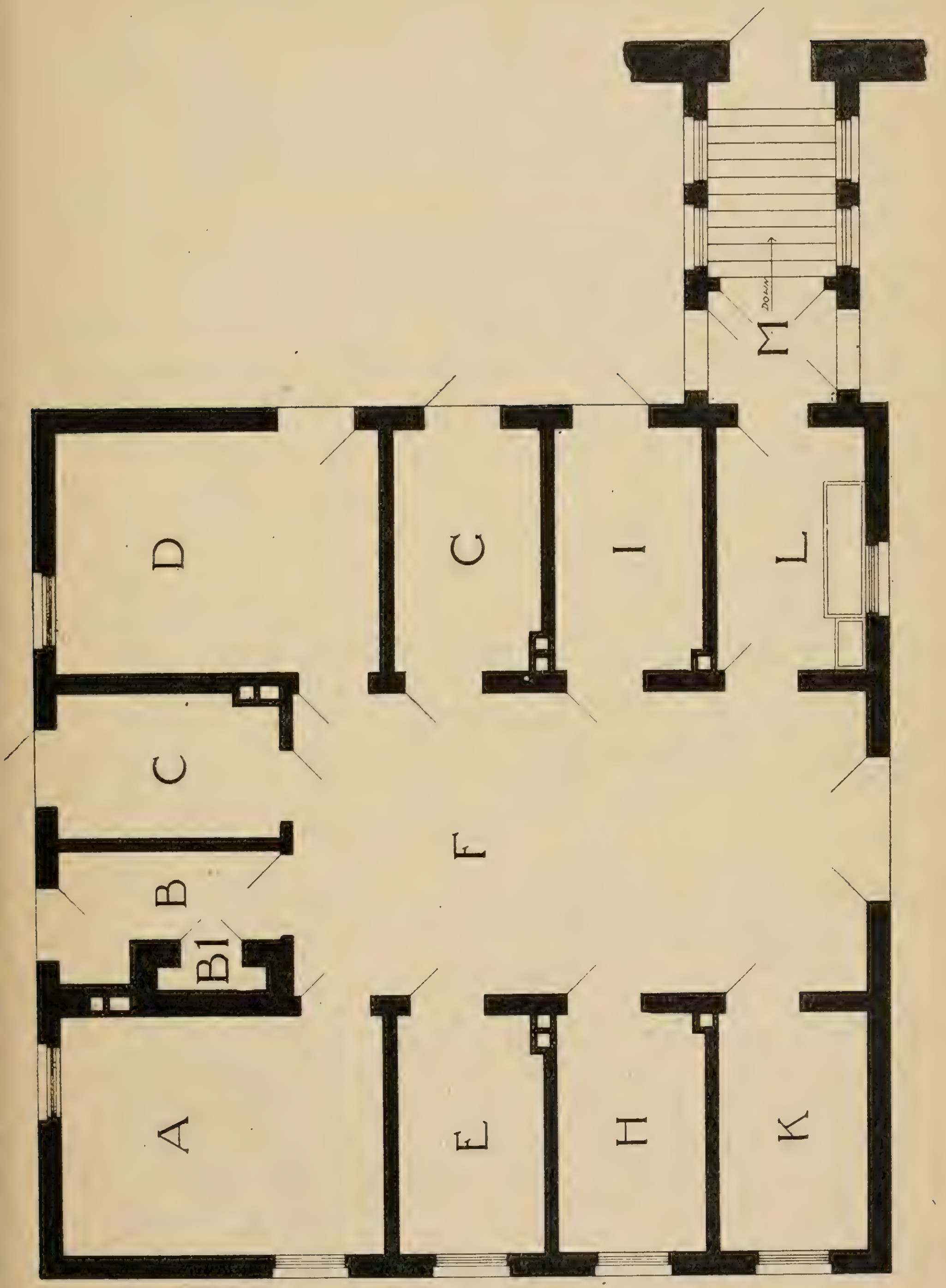


FIGURE IV.—HOSPITAL STABLE.

M represents corridor connecting laboratory and stable, L small operating room, F court, B crematory room, A C D G I E H K closed stalls.

REPORT OF THE DEPARTMENT OF ENGLISH AND MODERN LANGUAGE OF THE MICHIGAN AGRICULTURAL COLLEGE FOR THE YEAR 1903-1904.

To the President:

Sir—The arrangement of work in this department for the year 1903-1904 was identical with that of the previous year, and I refer you to the report of that year for details. The teaching force remained the same, and it gives me pleasure to testify to their continued efficiency and devotion to the work.

The enrollment for the year in the different subjects of the department was as follows:

English Work.

Sub-Freshmen—		
English Grammar	231	
English Composition	230	
Voice Culture	181	
Rhetorical Praxis	121	
Rhetoric	57	
Oratory and Debate	67	
Logic and Argument	114	
English Literature	107	
Orations	72	
Total enrollment (English)		1,180

Modern Language Work.

German	138	
French	29	
Total enrollment (Modern Language)		167
Grand total		1,347
Names repeated		684
Total number of persons registered in department		663

1. Average number of recitation hours per week per student actually enrolled (in English)	3.72
2. Average number of recitation hours per week per student actually enrolled (in German and French)	5.00
3. Average number of recitation hours per week per student during his course (in English alone):	
Highest possible	3.66
Lowest possible	1.50
4. Actual average number of recitation hours in English taken per student per week during his college course	2.70

ENROLLMENT BY TERMS.

English Work.

FALL TERM.

Sub-Freshmen—

English Grammar	218	
English Composition	213	
Voice Culture	180	
Rhetorical Praxis	110	
Oratory and Debate	51	
Logic and Argumentation	53	
Orations	68	
Total enrollment (in English)		893

Modern Language Work.

German	94	
French	24	
Total enrollment in (Modern Language)		118
Grand total for term		1,011
Names repeated		387
Number of persons actually enrolled		624

1. Average number of recitation hours per week in English per person actually enrolled in English 3.35
2. Average number of recitation hours per week in Modern Language per person actually enrolled 5.00
3. Average number of recitation hours per week in English, per student, for this term in his course:
   - Highest possible 3.00
   - Lowest possible 1.00
4. Actual average number of recitation hours in English taken per student per week in this term during his course........ 1.80

English Work.

WINTER TERM.

Sub-Freshmen—

English Grammar	179	
English Composition	177	
Voice Culture	155	
Rhetorical Praxis	89	
Oratory and Debate	59	
Logic and Argumentation	61	
English Literature	76	
Orations	18	
Total enrollment (in English)		814

Modern Language Work.

German	102	
French	18	
Total enrollment (in Modern Language)		120
Grand total for term		934
Names repeated		392
Number of persons enrolled		542

1. Average number of recitation hours per week in English per person actually enrolled in English	4.09
2. Average number of recitation hours per week in Modern Language per person actually enrolled	5.00
3. Average number of recitation hours per week in English, per student, for this term in his course:	
Highest possible	4.20
Lowest possible	1.72
4. Actual average number of recitation hours in English taken per student per week in this term	3.17

English Work.

SPRING TERM.

Sub-Freshmen—

English Composition	120	
Rhetoric	57	
Voice Culture	91	
Rhetorical Praxis	82	
Oratory and Debate	37	
English Literature	104	
Total enrollment (in English)		491

Modern Language Work.

German	78	
French	5	
Total enrollment (in Modern Language)		83
Grand total for term		574
Names repeated		182
Number of persons actually enrolled		392

1. Average number of recitation hours per week in English per person actually enrolled in English	3.80
2. Average number of recitation hours per week in Modern Language per person actually enrolled in Modern Language	5.00

3. Average number of recitation hours per week in English, per student, for this term in his course:
   - Highest possible 3.80
   - Lowest possible 1.75
4. Actual average number of recitation hours in English taken per student per week in this term........................... 2.61

NOTE:—The discrepancy between average (1) and average (4) is explained by the fact that average (1) deals with students actually enrolled in the English department and doing work in English during the term or the year; while average (4) takes in all regular students doing work in the three courses of the college. In several terms and during a whole year of one course no English work is assigned. The average number of recitation hours in English for a four-year agricultural student during his course is 3.08; for a five-year agricultural student it is 3.50; for a mechanical four-year student it is 1.50; for a mechanical five-year student it is 2.33; for a four-year woman student it is 3.33; and for a five-year woman student it is 3.66. In the mechanical courses a correspondingly larger amount of modern language work is required.

The department has been unusually successful in oratory and debate during the past year, winning by a unanimous decision the debate with the Normal College on the question: "Resolved, that the restrictions placed on the suffrage in Mississippi by the State constitution in effect January 1, 1892, are legally and morally justifiable," and tying for second place, according to ranks in the Inter-collegiate Oratorical Contest. In the debate we had the more unpopular, the affirmative, side of the question. I take much pride in recording here that, in spite of any unconscious prejudice on the part of judges against an agricultural college in such contests, in the three debates so far with Ypsilanti, out of the nine votes cast by judges, they have received only one vote more than ourselves; while in the inter-collegiate oratorical contests of the last four years the averages of the awards give us the second place in a list of nine colleges, with the exception of ourselves, mainly denominational and purely literary. In my opinion such facts are strong and convincing evidence, not merely of the efficient work of the English department, but more especially of the value of the training given by our system of education, enabling the student to acquit himself as a man, not only in the matter of earning a livelihood, but also in all the relations of life. Here, in the realm distinctively appropriated by the literary college, we find him facing his competitors as an equal among equals; and with the equipment that the Agricultural College gives, winning from them not only respect but also victory.

In this connection, and in view of the fact that during the year serious effort has been made to diminish the time devoted to English work, I desire to discuss somewhat at length the relation of the English work to the curriculum of our college.

The Agricultural College as an educational institution is, it is true, a distinct and well-defined revolt from the ideals and methods of the old education. It recognizes the material needs of men as primary, and the preparation for meeting those needs as the proper and legitimate business of education. It teaches agriculture instead of Latin because agriculture enables one to win his bread, while Latin does not. It goes further than this; it systematizes and dignifies such subjects as agriculture and seeks to give them an educational as well as an utilitarian value. But education at an agricultural college, while thus rightly and

properly utilitarian and intensely "practical," should not be narrowly and sordidly so. While rejecting the agencies through which the old education worked, it cannot afford and must not be allowed, to repudiate the broad humanism and culture for which the old education stood. No matter at what cost, we cannot afford to entrust our young men to any form of education which, however technical and "practical," does not recognize the man beyond and above the workman or the expert. While it prepares for industrial life, it must also prepare for political, social and moral life. While it trains the hand and the eye, it must also sharpen the intellect, enlarge the range of thought, strengthen and control the sympathies and emotions. It should take the raw, awkward boy, inexact in thought and without mental perspective, give him a part in the world's work, put a weapon in his hand wherewith to maintain and advance his position, and transform him into a man, keen and alert to utilize the forces operative around him, orderly and systematic in thought and action, broad-minded and philosophic in his outlook, sane, prudent and rational in forming opinions, loyal and unselfish in his relations to his country, and modest, tender and true in all the relations of life. It should recognize *character* as by far the most important factor in the attainment of true success, and the formation of character as a matter of persistent and intelligent training.

For this transformation it should and does use mainly the material world and the sciences that directly deal with industrial life; but it should recognize that the material world is only half the universe, and that the world of man, the civilization into which we are born and under the conditions of which we work and live, constitutes the other half. Hence it should not neglect to acquaint the student with the ideals, the feelings, the strivings, the achievements of the race, and to evolve therefrom a true philosophy of conduct. It may well cast aside the outgrown shell of idle fancies, it may well refuse to busy itself with a past that serves no present useful purpose; but it should not despise the past merely because it is past, for there it finds a solid foundation for the present and the future.

In such a scheme of education, the department which I have the honor to represent, will be looked upon, not with mere tolerance or even as an intruder, but as playing a necessary and integral part. Even if its function were merely to teach correct spelling and the orderly construction of the English sentence, its right to a position in such a curriculum would be recognized. For the logical construction of one's sentences means training to order, discipline, system in the processes of one's thought—no small desideratum at this particular time, when even among the better classes of our public men, looseness, incoherency, lack of orderly progression in thinking leads to so many wild vagaries, so much silly and harmful action in public and private life. I have not forgotten Molière's ridicule of the dancing-master's exaggerated claims for the far-reaching influence of his art; yet it nevertheless remains true that the skillful, forceful handling of the English sentence is in and of itself an accomplishment that goes far toward the attainment of success—an accomplishment not gained without long and severe training, and that training is primarily in order, logical sequence, and coherency of thought, clearness, accuracy of expression means necessarily clearness and accuracy in thinking.

But the English work does for the student far more than this. It takes him up, so to speak, into a high mountain and spreads before him as a promised land the glorious panorama of human ideals, aspiration, and achievement. It broadens his range of mental vision. It places his whole life on a higher plane. It leads him to feel a noble shame for the petty and the base, and stimulates all the generous and holy impulses of his nature. It enables him to distinguish mere shallow frothing and tinsel glitter from the serene and enduring splendor of great thought. It makes him the master of himself, calm and sure of footing amid the turmoil and confusion of a thousand conflicting cries. He is no longer the mere puppet of environment, of party, of the ebb and flow of popular thought. To a larger degree, in my opinion, than any other subject, the study of literature moulds and beautifies the character.

In this discussion I do not mean to claim all intellectual training and all moral value for the subjects of my department. That would be absurd. The highest intellectual strength is requisite for coping with the problems of science; and I am well aware that all science, when properly taught, emphasizes the value of absolute truth, and trains to perseverance, system, economy—indeed, as I have elsewhere expressed it, there is no subject or occupation which, pursued with vigilant mind and broad, thorough-going interest, does not train the faculties of mind and heart, and does not in a truly noble sense, *educate*. At the same time I do maintain that, in the M. A. C. system of education, our department and that of History and Political Science represent in a peculiar sense the knowledge of man and society as opposed to nature, notwithstanding the fact that man himself, his institutions and his achievements, constitute only a broader Natural History; and that, as man's differentiation from the lower animals and his progress and development have proceeded mainly along intellectual and moral lines, the study of this moral and intellectual development and its products must influence most directly and powerfully the young man's modes of thought and motives for action. If such be the case, surely there can be no question of the supreme value of such a factor in education. In no system can it be regarded as an interloper, but in all it becomes an imperative necessity. Omit it and you have the *mere* specialist,—brilliant possibly, but not the man our world of today needs. In too many cases, even with our best and wisest effort in training, the mere expert has become a freebooter, rendered more powerful, by the education which the State has bestowed, to rob and pillage the social organization that gave him his strength.

It may be urged that, while our work is important as stated, it should be accomplished in the preparatory school or the high school. That it *is* done no one familiar with school matters will maintain. But the stronger and more pregnant answer is, that to expect the high school to do more than make a beginning of such work, broad, deep, and high as it is, is absurd; and that, too, through no fault of the high school. No one expects the high school to *finish* the subject of Botany, or to treat it in a manner even remotely satisfactory for a college man. The college itself is far from exhausting any phase of the subject. Why, then, should it be imagined that the subject of expression, or that of literature, can be any more adequately treated in the high school, or

that their beneficent influence on the mind and character can there be safely suspended? When the average student finishes his high school work, he is just beginning to develop certain of his faculties, especially on the emotional side. He is just beginning to be able in some degree to assimilate the thought of the great intellects whose highest and most lasting product is literature. It is during this final period of plasticity, before the character hardens into its permanent form, in other words, during the four or five college years, that the best and most effective shaping and moulding must be accomplished. It is certainly not a specialist in education who dreams that the great subjects through which education is accomplished can be successfully treated as horizontal layers or strata to be deposited in the mind of the student. "Line upon line, precept upon precept, here a little and there a little," is still the secret of the successful educator. I strongly believe and affirm that during the four years of college life it is a positive crime under any circumstances to neglect the aesthetic and moral life, to cease effort *directly* to form and mould the emotional nature, to forego the opportunity to create wider interests in life, a broader outlook, a stronger character. The utilitarian idea in education, while correct within limits and a distinct step forward in adapting college education to the needs of the masses, becomes a most dismal failure, a most disaster-threatening menace to social and national life, if it is allowed to degenerate into mere sordidness, if it deliberately or impliedly teaches the student to measure all achievement by the base standard of dollars and cents. After all, the college exists for the student, not the student for the college. Its function is to create for him a broader life, not to put blind bridles over his eyes that he may look only in the direction his master desires.

How much time, then, should be given to the work which our department does for the student? Without discussing the question in the abstract, I reply with another question. In view of the enormous interests to be cared for, as inadequately presented in the foregoing, is the average time at M. A. C. actually devoted to the English work, as presented in the statistics at the head of this report, too much? It is perhaps a little less than that given to the Miliary Department. The average student at this College, rightly or wrongly, takes certainly not less than 30 hours of class-room work per week; nine per cent, therefore, of the whole work of the student at this College is on the average devoted to this phase of his education. In the course into which the English work most largely enters, the women's it amounts to only 16½ per cent of her whole time. Considering our problem as primarily an *educational* one—and that is what it is, disguise it as we may—I respectfully repeat my question, is nine per cent, or even 16 per cent, too much?

I confess that I have been much pained and discouraged by the effort to decrease the time devoted to the work of this Department and especially by some show in the Faculty of lack of sympathy with our work. That any little success of this Department in competition with other colleges should cause, not pleasure, but publicly expressed anxiety for the future of the College on the part of any of my associates has filled me with wonder. A long familiarity with the work of industrial and technical education for which our Agricultural College stands has given me every opportunity to understand its problems, purposes and methods.

I am thoroughly loyal to and in sympathy with it, and I am equally sure that its original and basic principles generously recognize the vital part played by the work of this Department.

In making this report I have taken the only opportunity offered during the year to make such representations as would somewhat adequately put forward my side of the matter. I respectfully submit the report to your consideration.

HOWARD EDWARDS,
Professor of English and Modern Languages.

Agricultural College, Mich.
June 30, 1904.

DEPARTMENT OF HISTORY AND ECONOMICS.

To the President:

I have the honor to submit the following report concerning the Department of History and Economics for the school year 1903-1904. The total number of enrollments of students in this Department during the year was 445 distributed as follows:

By terms—Autumn, 67; winter, 201; spring, 177.

By classes—Freshmen, 77; Sophomores, 97; Juniors, 95; Seniors, 53; Sub-Freshmen, 99.

By Subject—History, 244; Political Science, 122; Political Economy, 46.

The total number of hours taught was 867, divided among the three terms as follows: Autumn, 10 per week; winter, 33, and spring, 31.

The most insistent need of this Department is a class room permanently at its disposal. During the past year five different class rooms have been used for the recitation work of this Department, and the inconvenience and wastefulness of transferring maps and other illustrative material from one room to another, or often from one building to another, is no small hindrance to good class work.

In conclusion I take pleasure in commending the praiseworthy efforts of Mrs F. H. Hendricks, who rendered valuable assistance during the winter and spring terms as a teacher of History and Political Science.

Very respectfully,
WILBUR O. HEDRICK.

Agricultural College, Mich.
June 30, 1904.

REPORT OF LIBRARIAN.

To the President:

Sir—I have the honor to present the following report on the Library for the year ending June 30, 1904:

During the year we have added to the Library 915 bound volumes, of which 205 were purchased, 557 were donated, and 153 by binding. Unbound volumes and pamphlets to the number of 340 have been received, and in all cases, where donors were known, acknowledgment was made. We therefore omit individual mention.

We are indebted for bound volumes as follows:

*Abbott, Mrs. T. C., 377.
American Duroc-Jersey Swine Breeders' Ass'n, 1.
American Berkshire Ass'n, 1.
American Short Horn Ass'n, 12.
American Hereford Cattle Ass'n, 4.
American Aberdeen Angus Ass'n, 8.
Berry Brothers, 1.
Burrows, Hon. J. C., 4.
Black Top Spanish Merino Ass'n, 2.
Canada, 5.
Columbus Horticultural Society, 1.
Delaware Board of Agriculture, 1.
Hepburn, Hon. A. B., 1.
Holstein Freisian Herd Book, 2.
Harper Brothers, 1.
Kansas Academy of Science, 1.
Massachusetts Board of Agriculture, 1.
Maine, 2.
Missouri Botanical Gardens, 2.
Michigan reports, 14.
New Brunswick, 1.
National Shropshire Registry Ass'n, 1.
New York State Library, 6.
National B'd of Char. and Corrections, 1.
North, Hon. S. N. D., 1.
Red Polled Cattle Club, 1.
Smithsonian Institution, 5.
Shropshire Swine Breeders' Ass'n, 1.
Stearns, Hon. J. M., 1.

United States Reports, as follows:

Department of Agriculture, 1.
Bureau of Education, 3.
Civil Service Commission, 1.
Interior Department, 75.
Navy Department, 2.
War Department, 9.

Forty-four foreign publications, and 111 American periodicals are purchased by the College and placed in the reading room for the use of faculty and students.

In addition to these are the following publications which are regularly received in exchange for our own publications, or through the courtesy of publishers:

American Blacksmith.
American Missionary.
American Society of Civil Engineers, Transactions of.
American Swineherd.
American Horsebreeder.
American Phil. Society, Proc.
Adrian Times.
Allegan Gazette.
Ann Arbor Argus, Dem.
Agricultural Epitomist.
Agricultural Gazette of N. S. Wales.
Agricultural Advertising.
American Thresherman.
Arboriculture.
Baltimore Sun.
Battle Creek Journal.
Bay City Tribune.
Belding Banner.
Big Rapids Herald.
Brief.
Congressional Record.

*The books presented to the library by Mrs. Abbott numbered about 800 volumes. We include in this report only the number catalogued and made ready for the shelves during the year.

Capital City Democrat.
Christian Science Sentinel.
Christian Science Journal.
Christian Herald.
Church Helper.
Clinton Independent.
Chicago Packer.
Chicago Live Stock World.
Chicago Drovers' Journal.
Detroit Farm and Live Stock Journal.
Dairy and Produce Review.
Dutch American.
Electrical Trade.
Eau Clair Enterprise.
Farm and Fireside.
Farm, Field and Fireside.
Farm and Home.
Farm Home.
Farm Journal.
Farmers' Voice.
Farmers' Advocate.
Farmers' Guide.
Farming World.
Florists' Exchange.
Fruit Growers' Journal.
Farm News.
Good Health.
Gleanings in Bee Culture.
Grand Rapids Post.
Grand Ledge Independent.
Grange Bulletin.
Gas Engine.
Hillsdale Leader.
Hillsdale Standard.
Hoard's Dairyman.
Home and Farm.
Home Companion.
Homestead.
Horse World.
Horticultural Visitor.
Horseshoers' Journal.
Indiana Farmer.
Ionia Sentinel.
Improvement Era.
Independent Democrat.
Journal Victoria Dept. of Agriculture.
Journal of Agriculture (Australia).
Johns Hopkins Univ. Circulars.
Kalamazoo Telegraph.
Kansas Farmer.
Lansing Journal.
Livestock Journal.
Literary News.
Locomotive.
Michigan Presbyterian.
Michigan Mirror.
Midland Republic.
Monthly Weather Review.
Moderator.
Mystic Worker.
Mark Lane Express.
New Voice.
New York Meteorology.
New York Weekly Witness.
New York Produce Review.
National Farmer and Stock Grower.
National Stockman and Farmer.
Official Gazette.
Onekema Lake Breeze.
Orange Judd Farmer.
Park's Floral Magazine.
Petoskey Independent, Democrat.
Pinckney Dispatch.
Plymouth Weekly.
Practical Farmer.
Republic.
Rural Advocate.
State Republican.
Saginaw News.
Salt Lake Herald.
Traverse Bay Eagle.
Western Society of Engineers.
Williamston Enterprise.
World's Fair Bulletin
Western Swine Breeder.
Ypsilantian.
Yale Expositor.

The M. A. C. Record exchanges are placed in the reading room, and in exchange for our catalogue, the Library receives the year books, catalogues or registers from all the leading institutions of the country. We also receive the bulletins of the various State experiment stations, and of the U. S. Department of Agriculture.

During the year fines to the amount of $16.80 have been collected; about 5,000 books have been loaned. No record being kept of books used in the Library.

The Library hours remain unchanged.

To the library of the Experiment Station 55 books have been added. Eleven of which were purchased, nine by gift, and 35 from the bindery. This library now numbers 2,105 volumes, the College Library contains 22,868 volumes; total in both libraries, 24,973 volumes.

During the year the Library received from Mrs. T. C. Abbott a gift of books numbering about 800 volumes, part of the library of her late

husband, who was president of this College for 22 years. During the summer vacation the Librarian catalogued and made ready for the shelves 377 of these books. The remainder will be arranged as time permits.

On October 15 the position of Assistant Librarian was made vacant by the resignation of Mr. H. K. Patriarche. His work in the Library had been most efficient and his departure was regretted by all. He was succeeded by Miss E. Armstrong, who remained until December. The present assistant, Miss Caroline Balbach, was appointed January 1, 1904. In her work she is painstaking and interested, and we have great pleasure in commending her.

Respectfully submitted,

LINDA E. LANDON,
Librarian.

Agricultural College, Mich.
June 30, 1904.

REPORT OF FORESTRY DEPARTMENT.

To the President:

Sir—I have the honor to submit the second annual report of the Department of Forestry for the year ending June 30, 1904.

The work started last year has been carried on and extended as far and as fast as funds would permit. There is no other kind of crop that takes so long to get started as a forest crop which is all the more reason why propagation and planting should be pushed vigorously at the very start. The trees that were planted in the spring of 1903 made fair growth during the season. In the nursery the Norway pine and locust made the best growth. Some of the locust were five feet high five months from seed. Exhibitions of forest trees grown from seed were made at the State fair at Pontiac and at the West Michigan State fair at Grand Rapids. In each case the exhibit was especially attractive to visitors. It was probably the largest and perhaps the first exhibit of this kind made at the State fair.

Planting toward an arboretum is continued in the river woods shown on the plot as field number 20.

Improvement cuttings have been continued in numbers 20 and 17.

One hundred twenty-two and three-fourths (122¾) cords of 16-inch and twenty and one-half (20½) cords of 36-inch wood have been cut and sold. Two dollars and a half per cord has been received for nearly all of the 16-inch and from $2.50 to $4 per cord for the 36-inch. Sixty-five and seventy-five cents per cord were paid for cutting, and the cost of delivery was about the same, leaving a stumpage price of $1.20 for the 16-inch and from $1.20 to $3.50 for the 36-inch.

During the spring just passed 8,000 trees from our own nursery and as many more purchased have been planted permanently and 10,000 more have been purchased and planted in the nursery for future per-

manent planting. Seven thousand yearling Norway pine have been transplanted in the nursery, thereby thinning the 3,000 sufficiently that they can grow during this year where they grew last year.

Further work on methods of growing forest trees has been done. Three-fourths of an acre on the west end of field 18 has been planted by the furrow method with good promise of success. Further planting has been done in field 17 where the fire from the railroad ran over on May 18, 1903.

Two hundred trees, 100 willow and poplar cuttings and quantities of tree seeds have been shipped to the manager of the sub-station at Chatham on the Upper Peninsula. Report is received that the locust are doing well. Fifty locust and 50 catalpa trees and some willow cuttings and roots of crab grass were planted on a small spot on a large sand dune in Newaygo county. Reports received say that the trees are alive and growing. Exchange of tree seeds and cuttings is being carried on with Mr. L. A. Dode of Paris, France.

Equipment for outside work and laboratory work has been increased as far as funds would permit. A large number of photographs of objects of interest in forestry have been taken.

This Department was asked to make a forest nursery model and to prepare photographs showing the silvicultural conditions of the United States for use at the Louisiana Purchase Exposition at St. Louis. The government furnished funds for the preparation of this exhibit.

The collection of specimens of interest in forestry has continued. We are in great need of a suitable place in which to exhibit such material.

This Department has been doing full class-room work during the year. Two men have been graduated from the forestry course. Lower classmen will fill the schedule of work for next year. During the year seventy-one (71) students have received instruction in forestry in this Department during the past year as against 37 the previous year.

Lectures on forestry have been delivered before short-course students and farmers' institutes.

The Department has made as rapid development as circumstances would permit.

Respectfully submitted,

E. E. BOGUE.

Agricultural College, Mich.
June 30, 1904.

REPORT OF THE DEPARTMENT OF MATHEMATICS AND CIVIL ENGINEERING.

To the President:

Sir—The work of this Department for the past year has yielded results much better than we had reason to expect. The disadvantages under which the work was carried on were manifold, but loyalty and zeal on the part of instructors and energetic endeavor on the part of the student body have minimized the effect of hindrances.

We began the year with only three of the old teaching force, Assistant Professor W. Babcock, Instructor L. F. Harza and the writer. Besides these, four other instructors were provided and shared the work of teaching, namely Mr. R. Hopkins, Instructor in Mathematics and Civil Engineering, and Messrs. W. J. Carrel, G. W. Hartwell and A. E. Jones, Instructors in Mathematics. Instructors Harza and Carrel have resigned, and will leave us at the end of the school year.

The following text-books have been used in our classes during the year: Beman & Smith's Higher Arithmetic for classes in mensuration; Beman & Smith's Academic Algebra for all beginning classes formed by women and agricultural students; Wells' Essentials of Algebra for the fall term work of women and agricultural students; Van Velzer & Slichter's University Algebra for all engineering students; Wells' Geometry for engineering freshmen; Wentworth's Geometry for all other classes; Ashton & Marsh's Trigonometry; Tanner & Allen's Analytic Geometry; Taylor's Calculus; Hodgman's Surveying; Johnson's Surveying for all classes in higher surveying; Church's Mechanics; Merriman & Jacoby's Graphic Statics; Merriman & Jacoby's Bridge Stresses; Merriman & Jocoby's Bridge Design; Nagle's Field Manual for Railroad Engineers; Baker's Masonry Construction; Murray's Differential Calculus; Baker's Roads and Pavements.

The tabulation below exhibits in detail the class work of the Department, the various assignments of instructors and other items necessary to a complete record.

Class work of the department of mathematics and civil engineering for the college year 1903-04.

Class.	Subject.	Number of course.	Teacher.	Class-room.	Hour of meeting.	No. hours per week.	No. of students in class.
Fall term:							
Sub-freshmen...	M. algebra..........	Math. 1c......	Mr. Hopkins.......	Abbot Hall.......	8-9	5	27
" ...	" "	" 1c	" "	" "	9-10	5	25
" ...	" "	" 1c	Mr. Jones.........	Dairy............	8-9	5	24
" ...	" "	" 1c	Mr. Hartwell......	"	9-10	5	24
" ...	Ag. & W. algebra	" 1	" "	Dairy............	10-11	5	25
" ...	" " "	" 1	Mr. Carrel	8, College Hall.....	8-9	5	30
" ...	" " "	" 1	" "	" " "	9-10	5	25
" ...	" " "	" 1	Mr. Hartwell......	Dairy............	11-12	5	18
Freshmen	M. algebra	" 1e	Prof. Babcock	6, College Hall.....	1-2	5	17
"	" "	" 1e	" "	6, " "	9-10	5	22
"	" "	" 1e	Mr. Harza	Dairy............	10-11	5	20
"	" "	" 1e	" "	6, College Hall.....	2-3	5	37
"	" "	" 1e	Mr. Hopkins.......	Abbot Hall........	10-11	5	25
"	" "	" 1e	Mr. Jones.........	Bot. Lab..........	10-11	5	24
"	Ag. & W. algebra	" 1b	Mr. Carrel	8, College Hall	10-11	5	32
"	" " "	" 1b	" "	8, " "	3-4	5	23
"	" " "	" 1b	Mr. Harza	8, " "	1-2	5	24
"	" " "	" 1b	" "	6, " "	3-4	5	18
"	" " "	" 1b	Mr. Jones.........	Abbot Hall........	3-4	5	21
"	M. geom.	" 2d	Mr. Hartwell	Dairy............	8-9	5	21
"	" "	" 2d	" "	Abbot Hall........	1-2	5	20
"	" "	" 2d	Mr. Carrel.........	8, College Hall.....	11-12	5	22
"	" "	" 2d	Mr. Jones	Bot. Bldg.........	11-12	5	21
"	" "	" 2d	" "	Dairy............	1-2	5	38
"	" "	" 2d	Mr. Harza...	"	11-12	5	16
Sophomores	Analytic geom	" 5	Prof. Babcock	6, College Hall.....	8-9	5	26
"	" "	" 5	" "	6, " "	10-11	5	27
Juniors	Mech. of eng	" 7a	" "	6, " "	11-12	5	18
"	" "	" 7a	Mr. Hopkins.......	2, " "	11-12	5	16
"	Surveying (class)......	Civ. eng. 1b ..	Prof. Vedder......	2, " "	10-11	2	33
"	" (field)	" " 1b ..	Prof. Vedder and...	....	1-3	2	18
"	" "	" " 1b ..	Mr. Carrel.........	....	1-3	2	15
Seniors	Ag. Civ. eng. (class) ..	" " 2 ..	Prof. Vedder......	2, College Hall	10-11	5	12
"	" " " (field) ..	" " 2 ..	" "	....	1-3	2	12
"	Graphics............	" " 4 ..	" "	2, College Hall	8-9	3	24
"	R. R. Surveying	" " 7 ..	Mr. Hopkins.......	2, " "	1-4	6	9
"	Bridge Stresses.......	" " 8a ..	Prof. Vedder......	2, " "	10-11	3	8
Totals.......	37 sections..........	....	....	....	....	170	817
Winter term:							
Sub-freshmen ...	Ag. & W. algebra	Math. 1a	Mr. Carrel	8, College Hall	8-9	5	15
" ...	" " "	" 1a	" "	8, " "	9-10	5	18
" ...	" " "	" 1a	Mr. Hartwell	Dairy............	10-11	5	26
" ...	" " "	" 1a	" "	"	11-12	5	20
" ...	M. algebra...........	" 1d	Mr. Carrel	8, College Hall	10-11	5	19
" ...	" "	" 1d	" "	Abbot Hall........	2-3	5	24
" ...	" "	" 1d	Mr. Jones	Dairy............	10-11	5	20
" ...	" "	" 1d	" "	8, College Hall	2-3	5	23
Freshmen	Ag. & W. geom	" 2b	Prof. Babcock.....	6, " "	9-10	5	20
"	" " "	" 2b	Mr. Harza.........	Dairy............	9-10	5	15
"	" " "	" 2b	Mr. Hopkins.......	Abbot Hall........	9-10	5	22
"	" " "	" 2b	Mr. Hartwell	6, College Hall	2-3	5	21
"	" " "	" 2b	" "	6, " "	3-4	5	23
"	M. algebra...........	" 1f	Prof. Babcock.....	6, " "	11-12	5	23
"	" "	" 1f	Mr. Harza	Abbot Hall........	11-12	5	23
"	" "	" 1f	" "	6, College Hall	1-2	5	25
"	" "	" 1f	Mr. Jones	Dairy............	11-12	5	23
"	" "	" 1f	" "	8, College Hall	1-2	5	26

Class work.—Concluded.

Class.	Subject.	Number of course.	Teacher.	Class-room.	Hour of meeting.	No. hours per week.	No. of students in class.
Sophomores	M. Dif. calculus	Math. 6a	Prof. Babcock	6, College Hall	10–11	5	29
"	" " "	" 6a	Mr. Harza	Abbot Hall	10–11	5	26
Juniors	Mechanics	" 7b	Prof. Babcock	6, College Hall	8–9	5	16
"	"	" 7b	Mr. Hopkins	Abbot Hall	8–9	5	13
Seniors	Ag. Eng'g	Civ. Eng. 3	Prof. Vedder	2, College Ha	10–11	5	5
"	Bridge Design	" " 8b	" "	2, " "	9–10	8	6
"	Hydraulics (class)	" " 5	Mr. Hopkins	2, " "	11–12	5	12
"	" (lab.)	" " 5	" "		1–3	4	12
Totals	26 sections					132	505
Spring term:							
Sub-freshmen	Ag. & W. geom	Math. 2a	Mr. Jones	8, College Hall	8–9	5	24
"	" " "	" 2a	" "	8, " "	9–10	5	19
"	" " "	" 2a	Mr. Harza	Dairy	2–3	5	23
"	M. geom	" 2c	Mr. Carrel	8, College Hall	11–12	5	16
"	" "	" 2c	" "	Dairy	2–3	5	19
"	" "	" 2c	Mr. Hartwell	Abbot Hall	11–12	5	20
"	" "	" 2c	Mr. Jones	Abbot Hall	2–3	5	18
"	Mensuration	" 3	Mr. Carrel	8, College Hall	10–11	5	15
"	"	" 3	Mr. Hartwell	Abbot Hall	10–11	5	22
"	"	" 3	" "	8, College Hall	1–2	5	22
"	"	" 3	Mr. Jones	Abbot Hall	1–2	5	18
Freshmen	Ag. & W Trig	" 4a	Mr. Hopkins	Abbot Hall	8–9	3	24
"	" " "	" 4a	Mr. Carrel	2, College Hall	8–9	3	28
"	" " "	" 4a	Prof. Babcock	6, " "	10–11	3	27
"	M. Trig	" 4b	" "	6, " "	11–12	5	20
"	" "	" 4b	" "	6, " "	2–3 or 3–4	5	20
"	" "	" 4b	Mr. Harza	Abbot Hall	9–10	5	32
"	" "	" 4b	" "	Dairy	11–12	5	19
"	" "	" 4b	Mr. Hartwell	8, College Hall	2–3 or 3–4	5	19
"	Ag. Surv'g (class)	Civ. eng. 1a	Mr. Hopkins	2, " "	8–9	2	30
"	" " "	" " 1a	Prof. Vedder	2, " "	10–11	2	41
"	" " (field)	" " 1a	Prof. Vedder & Mr. Hopkins		1–3	2	24
"	" " "	" " 1a	Prof. Vedder & Mr. Hopkins		1–3	2	30
"	" " "	" " 1a	Prof. Vedder & Mr. Hopkins		1–3	2	17
Sophomores	Integ. Calculus	Math. 6b	Prof. Babcock	6, College Hall	9–10	5	30
"	" "	" 6b	Mr. Harza	8, " "	8–9	5	19
Juniors	Dif. Equations	" 8	Prof. Babcock	6, " "	10–11	2	31
"	H. Surv'g (class)	Civ. eng. 6	Prof. Vedder	2, " "	9–10	3	23
"	" " (field)	" " 6	Prof. Vedder & Mr. Hopkins		2–3	6	23
Seniors	" " (class)	" " 6	Prof. Vedder	2, College Hall	9–10	3	14
"	" " (field)	" " 6	Prof. Vedder & Mr. Hopkins		2–3	6	14
"	Masonry and Arches	" " 9	Mr. Hopkins	2, College Hall	10–12	8	8
"	Pavements	" " 10	Prof. Vedder	2, " "	9–10	2	10
"	Thesis	" " 11	" "	2, " "	2–4	12	6
Totals	32 sections					151	725
Grand totals	94 sections					453	2,047

At the present time we are occupying three class-rooms in College Hall, two in the Dairy Building, and one each in the Botanical Laboratory and Abbot Hall. Without doubt, we shall need another room for the coming year. Some of these rooms are inadequately equipped in seating capacity, blackboard space and desk conveniences.

The separation of our teaching force made necessary by this distribution of class-rooms renders the proper apportionment of work a difficult matter. In a number of instances during the year I should have made distinctly different assignments, based upon the teacher's particular ability and economy of energy, had it not been imperative to adjust these assignments to suit our extensive geographical arrangement. I am satisfied, too, that a distinct loss of efficiency arises from carrying on the work of the Department in places so far distant from the main office, and it is certainly impossible to give satisfactory supervision to all branches of department work under my charge.

For these and other reasons, I would urge that a sufficient number of class-rooms be provided in one building for the work of the Department.

Only one room is provided as an office, study and retiring room for all members of this Department. For very positive reasons, connected with the management of the Department, I desire that all teachers, when not occupied with teaching, report to some central meeting place. If the room provided as an office were used for no other purpose, it would obviously be too small to serve as such for seven persons; but this room, with dimensions 12x26 feet, is the only available place for storing our instrumental equipment, for assigning, delivering and receiving instruments used by students in the field, and for department library, student records and general storage.

Such a combination of uses produces very unsatisfactory conditions. Being so much of a laboratory, the room is not a place of privacy from student intrusion. Even use by the Department personnel makes it impossible for the head of the Department to hold private conference with student or instructor. Again, laboratory use by the students brings its attendant dirt and disorder, while the varied storage requirements render anything like neatness or arrangement, or even cleanliness, next to an impossibility. I most strongly urge that office space be provided sufficient to place a desk for each member of the Department, in which there shall be a private corner for the head of the Department. The lack of this provision has become annoying to the point of exasperation, and I feel that attention to this matter is absolutely necessary to the proper conduct of next year's work.

While the need of a separate room for an instrument repository has been apparent for many years, the desired improvement has not yet materialized. Promise of ample and convenient quarters in a new building to be erected some time in the future has led to unusual effort to preserve our equipment, even when housed under conditions which constitute a constant menace. Meanwhile, conditions grow worse; larger classes and more equipment both serve to intensify the reasons for urging the matter of proper and adequate storage and laboratory facilities.

With the establishment of a partial course in civil engineering in the fall of 1901, this Department assumed a half-obligation that for the first two years during which these civil engineering options were

allowed, no additions to teaching force would be required because of the extra work brought upon the Department. This agreement has been carried out, and without serious inconvenience to members of the Department. It is true that excessive requirements have been made of nearly all teachers in the Department; and we can, in justice, no longer be asked to furnish a good deal of a valuable product for nothing. If a proper amount and kind of instruction in civil engineering subjects is to be given, a commensurate allowance must be made in teaching force and some additions provided in equipment. The special appropriation of $1,080.00 just made by the State Board of Agriculture for new instruments is noted with pleasure, as is also the authorization of a new instructor in civil engineering.

The total expenditure by the Department during the year for all purposes has been $947.49, of which $133.00 was turned in for special examinations. The inventory of Department property, including instrumental equipment, class-room and office furniture, observatory apparatus and tools, shows an aggregate of $5,610.95 on June 30, 1904, as against $5,321.86 last year.

Respectfully submitted,

H. K. VEDDER,

Professor of Mathematics and Civil Engineering.

Agricultural College, Mich.

June 30, 1904.

DEPARTMENT OF PHYSICS AND ELECTRICAL ENGINEERING.

To the President:

I herewith submit my report for the year ending June 30, 1904.

On my accession to the position on the first of April, I found the work in Physics being very creditably carried on by Messrs. Holbrook, Curtis and Peters, although they were laboring under many disadvantages. Since my arrival, I have taught two classes and have been getting acquainted with the needs of the Department and the equipment. That the Physics Department needs a new building, has been stated by my predecessors, and is recognized by everyone. I find a fairly good equipment of lecture apparatus, but the equipment for the laboratory work of the students is very meager indeed. It is very embarrassing to have students come from well equipped high schools and undertake to perform experiments with apparatus considerably inferior to what they have been used to. The Board has shown very liberal spirit in providing for new apparatus for the coming year, at which I am very much pleased. We shall endeavor by fall to select a new text-book which will be better adapted to the needs of the students which we have, and this, with a few changes which we hope to make during the summer, will enable us to improve the facilities quite a little, although we cannot hope for anything like satisfactory improvement until we come into our inheritance of a new building.

My immediate predecessor urged that the Department should have a

building by itself, and in general this is quite true for work in Physics, but I think in this case it is not a *sine qua non.* It seems to me that it would be wiser to put up a large building which would house the Physics and Electrical Engineering work, and the two higher classes of Mechanical and Civil Engineering possibly. The Physics Department could occupy one extreme end of the building and be quite removed from heavy vibrating machinery which could be placed in the extreme other end, and thus one new building would relieve a considerable congestion which already exists in all three of the departments.

It is extremely essential in these days that engineering students should have a very generous knowledge of electrical work, and I am loath to allow even one year to go by without offering considerable work in electrical engineering, but the facilities at hand prevent very much being done along that line, although I shall endeavor to offer some work throughout the year in electrical engineering. During the spring term just past, we have felt the effect of the introduction of Sub-Freshmen classes, and next year our Department will be overwhelmed with students because of this. It is thus a very serious problem that confronts us to provide for the students for next year, as we shall have 1,200 students enrolled approximately, as against 723 students this year, and 429 students in the year 1902-1903.

From the interest shown by the students in the work of Physics and the demand for electrical engineering on the part of the students, and from the spirit which the Board has shown in providing the necessary equipment, I have high hopes of our having a Department in which we will all take considerable pride as soon as we enter the new building.

Respectfully submitted,

A. R. SAWYER,

Professor of Physics and Electrical Engineering.

June 30, 1904.

REPORT OF THE VETERINARY DEPARTMENT.

In reporting the work of the Veterinary Department for the year ending June 30, 1904, I have nothing new to offer. The work of the Department has been carried on in very much the same manner as in former years; methods are modified from time to time as the condition of the class seems to require.

We try at all times to keep in mind, that the object of the Department is to give a practical course for the young men who expect to engage in stock raising and so, while we discuss the diseases as to their causes, symptoms and treatment, we also call attention to the veterinary side of stock judging, breeding and feeding. The Seniors had the opportunity of electing the work throughout the entire year; the Sophomores received 30 lectures during the first half of the winter term, and the special short course students also received 30 lectures

during the same term. The classes met at different times and the lectures varied somewhat according to the requirements of the students.

Respectfully submitted,
GEORGE A. WATERMAN,
Professor of Veterinary Science.

Agricultural College, Mich.
June 30, 1904.

CHEMICAL DEPARTMENT.

President J. L. Snyder:

The College year of 1903-4 brought to the Chemical Department the largest amount of work which it has had to do any time within its history. The laboratory, which was originally constructed for the care and instruction of classes not exceeding fifty in number, must be considered very inadequate to provide economically for the instruction of classes numbering from one hundred to one hundred and fifty. The work done, however, I think has been of a grade which makes it comparable with the work done by students in previous years and in smaller classes, but it has been accomplished only by the expenditure of a great amount of energy and under serious disadvantages so far as economy of labor is concerned. The Chemical Department needs now the entire space afforded by the Chemical and Physical building and immediate steps should be taken to provide a proper laboratory for the Physical Department in order that their work, as well as our own, may not be performed at such a great disadvantage.

As an example of the crowded conditions under which we are obliged to work in our laboratory space, I wish to call your attention to the fact that during the Winter Term the main analytical room, which provides space for forty-eight students to work at once, is occupied constantly to its full capacity from 8:00 a. m. to 12:00 a. m. and from 1:00 p. m. to 5:00 p. m. Such an uninterrupted use of the room is both a hindrance to the student and a source of ill health to the instructors. Also in order to accommodate the large number of mechanical students in mineralogy during the Winter Term we were obliged to stage over the back half of the lecture room and fit the space thus provided for the accommodation of forty students. In this way only were we able to take care of the class in two divisions. The health of our students and our instructional force demands that adequate provisions be made at the earliest possible moment for greater laboratory space.

The following schedule shows the number of students who have received instruction during the year just closed:

Fall term.	No. of students.	Instruction, hours per week, per student.
General chemistry:		
Agricultural and Mechanical	240	7
Women	66	
Organic chemistry:		
Agricultural	40	
Women	55	7
Total hours instruction		2,807
Winter term.		
Mineralogy, mechanical	128	5
Qual. anal., women	47	10
Qual. anal., men	71	10
Agricultural chemistry, men	34	10
Domestic science	18	10
Total hours instruction		2,340
Spring term.		
Quan. analysis	8	10
Mechanical, third term	120	6
Sugar beet specials	18	30
Total hours instruction		1,340

I recommend that the special course in Sugar Beet Chemistry be discontinued after this year, that is, that it be not given in the year 1905. My reason for this is that various conditions have not favored the development of the industry in our State during the past few years, and there is a gradual closing down of the factories, hence a less demand for technically prepared men. Beginning in 1899 we inaugurated this course to meet the demand for factory chemists which was apparent and has continued, but I feel that having trained a large number of men for these positions at a considerable expense to the College that we have done enough and until the demand for more trained men is urgent it will be well for us to suspend the course. As in previous years this special course in Sugar Beet Chemistry has been in charge of Alfred N. Clark, sugar expert, who has rendered most efficient service, both as an instructor and demonstrator of the operations of the factory.

During the past year the regular instructional force has been made up as follows:

Mr. Harry S. Reed of Lansing, Michigan.

Mr. Ray R. Tower of Belding, Michigan.

Mr. Otice M. Riggs of Cambridge, Mass.

Mr. Perry H. Edmonds of Lansing, Michigan.

Mr. E. O. Elmer of Springport, Michigan, (for the fall term) all of whom have rendered most excellent service, which is hereby acknowledged.

There has been so much work in connection with the necessary teaching in the Department that I regret to say that I have had but little time for experimental work myself. I, therefore, have asked the Board for the coming year for an additional instructor who will be able to take up a portion of the work, allowing me more time for experimentation.

By vote of the Board, Mr. Harry S. Reed, who has been a valued assistant for several years past, was granted leave of absence from April 1st to September 1st in order that he might complete his studies and take his degree.

Mr. Louis G. Michael, who completed his work at M. A. C. in 1903 and acted also as instructor in this Department, was given a scholarship at Columbia University, where he has already distinguished himself.

Acknowledging your constant help and interest in the Department this report is respectfully submitted.

FRANK S. KEDZIE,
Professor of Chemistry.

Agricultural College, Mich.
June 30, 1904.

REPORT OF DRAWING DEPARTMENT.

To the President:

Dear Sir—The report for the Department of Drawing for the College year ending June 19, 1904, is herewith respectfully submitted.

In addition to the usual routine work customarily reported for several years past there are but few things to mention.

It has been found necessary to employ additional instructors during the year. In the fall and winter terms Mr. W. P. Robinson, of the Junior Engineers, instructed very acceptably sections in Mechanical Drawing, while in the winter and spring terms Miss Bessie Earl assisted in the free-hand drawing.

Mr. Chace Newman and Miss Caroline Holt have carried full assignments of work in their usual efficient manner.

In the winter term it became necessary to find an additional room to accommodate the class in Drawing and Design 7. Dr. Beal kindly allowed us the use of a small room in the attic of the Botanical Laboratory. This place was much too small and a great deal too cold for the best work, and whatever was accomplished was chiefly through the good natured perseverance of the members of the class.

With your knowledge of the conditions existing in the Department you will see that the highest economy in the use of the time of the instructing force is impossible. I appreciate the recent action of the Board making possible the permanent increase of our corps of instructors.

In addition to my Department duties I have been acting as class officer for the Sub-Freshmen of the Engineering course. While I am glad to make myself useful the duties connected with this work are exacting, not always pleasant, and, especially at the opening of the year, consume much time really needed for Department purposes.

W. S. HOLDSWORTH.

Agricultural College, Mich.
June 30, 1904.

REPORT OF ATHLETIC DEPARTMENT.

To the President:

I submit herewith a report of the Department of Physical Culture for the year ending June 30, 1904.

The work of the Department has been along two lines, gymnasium work and athletic. The object of each is the same—to build up strong, healthy bodies and to make manly men. Along the line of gymnasium work instruction has been offered in Indian clubs, dumb-bells, bar-bells, free arm and breathing exercises, apparatus work and indoor games. These classes were open to all, but the work was especially planned for those students not taking part in the general athletic work. This work proved popular and was largely attended by students from all classes during the winter months.

The athletics of the institution is divided into the general heads, football, baseball, basket-ball, track and indoor athletics. Our football team, during the past fall, played nine games, meeting with but one defeat and winning the State inter-collegiate championship with ease. In basket-ball we also had the strongest College team in the State.

The 1904 baseball team was unusually successful, playing a schedule of 16 games, of which 12 were victories.

In the State inter-collegiate series of six games all were victories and the pennant and championship cup resides with M. A. C. The track, relay and indoor teams also won those championships at the intercollegiate meet held at Albion early in June, scoring more points than the other five colleges combined.

M. A. C. was represented by one man at the World's collegiate championship games at St. Louis on June 25. Two second places were won, which placed M. A. C. in a tie with the University of Illinois for third place in the meet.

The new bath house, which was opened with this school year, has been a decided success. Equipped with fifteen shower baths, two tub baths, and an excellent swimming pool, it is not only of untold benefit to the young men as a whole, but, by furnishing dressing and bath facilities, has increased materially the benefits from the gymnasium and athletic work. It is unfortunate, however, that the bath house may be used only by those young men who elect to pay the one dollar and

a half fee. I believe the fee should be demanded of all the young men so that all would receive its benefits.

The athletic field is now in excellent shape. Movable bleachers have been added, which, with the new grand stand, gives a seating capacity of over 1,000. The cinder track has been regraded and recindered, and with the completion of the drainage system, which is being put in this summer, the field will be one of the best in the State.

The Department on a whole is well equipped with everything except gymnasium apparatus. Nothing has been added in this line for several years, and a small appropriation for that purpose is badly needed.

Respectfully submitted,

C. L. BREWER.

Agricultural College, Mich.
July 1, 1904.

REPORT OF MILITARY DEPARTMENT.

President J. L. Snyder, Michigan Agricultural College:

Sir—I have the honor to submit herewith, a report of the Military Department of the Michigan Agricultural College. I reported for duty at the College February 21, 1904. I found upon my arrival, that each company occupied the armory for one hour each week for drill. While these drills could not be fully extended on account of the small floor space, they answered so far as keeping the men in touch with what they had learned on the drill ground. Since the commencement of outdoor exercises, the work has been very much retarded on account of the stormy weather, I have endeavored, however, to make up for lost time as far as practicable. The time allowed by the Faculty (three hours per week) is entirely too short to cover the requirements of G. O. No. 94, dated Headquarters of the Army, Washington, August 9, 1902. Would it not be possible to extend the time on three days in the week to one hour and a half, say from 4:30 to 6 p. m.? A great deal of time is consumed in calling the roll, and it is impossible to get a full hour for drill. In this connection, I desire to state that there should be a certain time fixed by the Faculty for the theoretical instruction of officers and non-commissioned officers, one hour a week at least should be devoted to this. This instruction at present is voluntary on the part of the officers, and naturally not very regular in attendance, but if an order was made by authority of the Faculty, it would impress each one with the fact that this is a duty to be performed the same as any other.

With the out-door exercises that have been held, very good progress has been made. The officers are bright and active and quickly anticipate an order or command. I am also pleased to say that the men while in ranks give close attention to their duties.

Instruction has been given in the squad, company and battalion, in-

cluding extended order, guard mounting, signal and hospital corps drill, gallery target practice and advance and rear guard.

Captain Pegram Whitworth, 1st Infantry, U. S. Army, inspected the corps on the 24th of May last, nearly one month previous to the close of the College year. He saw everything except the cadets in extended order, they at the time not having been so far advanced. If the annual inspection had been delayed as requested by the President, a much better showing could have been made. However, from the remarks made by the inspector, I judge he was pleased with what he saw.

While I am a firm believer in athletics of all kinds, it seems to me that matches for baseball or other games could be made on dates that would not interfere with dates designated for military instruction. It is very apparent that both cannot be held on the same day and hour. To have to postpone a drill or any other instruction in the Military Department for a game of ball, is inclined to make the Department lose its dignity, and the respect of the cadets. It is hoped that a change in this respect be made as far as practicable.

There should be some means by which this Department could more accurately account for absentees. It is often the case when cadets have left College that the captain or first sergeant, having no knowledge of them, continues to carry them on the roll. My suggestion would be that where a man is reported absent twice in succession, the first sergeant be required to report to the Secretary's office and find out what the man's status is, and if he has left College to drop him.

It has been reported to me that very often cadets leave College, and not expecting to return, do not take the trouble to turn in their arms and equipments, but leave them with some one to do so for them.

To obviate this as much as possible, I would respectfully suggest, that all students who are to take the military instruction, before being classified in this Department and before arms and equipments are issued to them, be required to make a deposit of $5.00 with the College Treasurer, for which a receipt should be given, this to be shown to the battalion adjutant as a voucher for the deposit.

When a cadet is ready to leave College and has turned in the property for which he is responsible, he could get a clearance from this office for presentation to the Treasurer. If something of this kind could be put into effect, it would to some extent teach them what care and responsibility mean. They would think a long while before leaving five dollars behind.

A company competition drill was held on June 2, Capt. Merick's Company "D," was awarded the medal. A first sergeant's medal was competed for at the same time, this was awarded to First Sergeant H. S. Hunt of the same company. Col. Shubel, of Lansing, and an officer of the Michigan National Guard were the judges.

Very respectfully,

W. H. KELL,
Major U. S. Army.

Agricultural College, Mich.,
June 30, 1904.

ANNUAL REPORT OF THE DEAN OF THE SPECIAL COURSES.

To the President:

The methods of advertising the special courses in the fall of 1903 differed from those previously used in one respect only, more attention was paid to the organizations of farmers, the Grange, the Farmers' Club and the Gleaners. Lists of names of young men who might possibly be induced to take a course at the College were obtained from the officers of these organizations and circulars and personal letters sent to the young people themselves. It was found that a great majority of the young men thus solicited could not possibly come to the College in the winter of 1903-4, but hoped to do so at some future time. While, therefore, the advertising did not result in the expected increase of numbers for the past season, it is seed sown upon good ground, and if properly followed up during the years to come, cannot fail to bring a good many of our rural population to the College for the short courses. It will bring also the ones for whom the special courses are provided, the young men who cannot, for various reasons, leave the home long enough to take a full four years' course. The numbers in attendance upon the special courses offered were as follows:

Live stock, first six weeks	58
Live stock, second six weeks	14
Creamery, first six weeks	35
Creamery, second six weeks	11
Cheese	26
Fruit	9
Beet sugar	13

An attempt was made to give an advanced course to the live stock men and butter makers. There was no way of telling before hand how such a scheme would work. In the live stock course the method seemed to be successful, but with the creamery men results were otherwise. I should recommend, therefore, that in future the special courses be made eight weeks long instead of six and no supplementary courses be offered, unless indeed a short course covering the entire winter should be thought worthy of consideration in the immediate future. There come to us every season a few young men who desire to stay at the College a great deal longer than six or eight weeks and who would be glad of the opportunity to come here in late October, go home at Christmas for a vacation of a week and then return to remain until the beginning of the spring vacation. I believe it would be wise on the part of the College to consider the propriety of offering a course of study adapted to the wants of such young people and covering eight weeks before Christmas and the months of January, February and March. Such a course would need to include work with live stock, judging, feeding and veterinary science; work in agronomy, including soils and methods of crop production; work in botany, including systematic botany for both

terms with some instruction on plant diseases; some work in entomology, with training in the management of fruit orchards and some experience in agricultural chemistry. It seems to be definitely settled that it is unsafe to make a break in the middle of a course or to offer advanced courses, following directly after preliminary courses. At the same time it is clearly demonstrated that the six weeks' course is too short, hence the recommendation of a course eight weeks in length as a compromise, for the young men who can come for that short time only but urging that arrangements be made for a course to last all winter as outlined above.

The State is now reaping a part of the benefits of the special courses heretofore given. Certainly more than half of the cheese makers now doing business in Michigan were instructed at this College and nearly if not quite half of the butter makers. I am assured that the improvement in the quality of the goods as to uniformity as well as high scoring quality is very marked. The requirement that young men should have had some experience in practical work before taking either course last winter was justified by this fact. Not a few men who have taken one course desire to come back for a second term, besides no young man could appreciate the advanced instruction given who had not met the difficulties occurring in actual factory work by experience at the vat or churn. It is proposed to extend and improve the instruction next year and in the courses to follow, assuming an acquaintance with the ordinary daily routine of the factory and giving especial attention to the factors upon which the perfect quality of the butter or cheese depends, such as cleanliness, the production of pure milk, pasteurization and the making and uses of starters and cultures.

While the benefits to the State accruing from the short course in live stock and general farming are not so conspicuous as are those from the two courses just mentioned, they are even more cogent and valuable. There are scattered through the length and breadth of the State a large number of young farmers who are doing vastly better work and who are succeeding financially because of their attendance at the College for six weeks studying soils, crops and live stock. I am glad to report that the class leaving us in the spring of 1904 contained an unusual number of high school graduates and was exceptionally high in intelligence and energy.

Although the numbers in attendance upon the fruit course were not large the work accomplished was very satisfactory. There seems to be a reluctance on the part of young men living in the so called fruit belt, to avail themselves of the advantages of this course. The presence of the insect and fungous diseases and the consequent necessity of repeated spraying combined with the uncertainty of the season and the keen competition is allowing the bulk of bright young men in that favored region to drift to Chicago and other large cities, there to enter upon a business that they know nothing about, but which gives them the false promise of quicker financial returns and a less arduous life. There is certain to be a reaction in this matter shortly and this special course will aid in clarifying the vision and saving some of these young people from the consequences of this delusion.

In closing I cannot refrain from calling to your attention the excellence of the instruction along all lines offered in these courses, nor would

it be just to forget the kindness of Michigan citizens in cooperating with the College in making these courses more effective. Distinguished lawyers have come to the College without pay to lecture to the young men on certain phases of the rights and liabilities of farmers, stock breeders have come from this and other states to explain to the classes the methods which they have employed with success, and fruit men have found it possible to visit us with a systematic account of the best methods of handling fruit plantations. A partial list of the men to whom both the College and the classes interested are indebted for favors of this kind follows:

H. E. Thomas, attorney-at-law, Lansing; C. F. Hammond, attorney-at-law, Lansing; F. E. Robson, attorney-at-law, Detroit; C. B. Collingwood, attorney-at-law, Lansing; Frank Crandall, breeder of Holstein cattle, Howell; E. O. Bradfute, breeder of Angus cattle, Xenia, Ohio; J. J. Ferguson, in charge of cattle food department, Swift & Co., Chicago, Illinois; J. T. Parks, Sanitary Milk Co., Grand Rapids; C. B. Cook, fruit grower, Owosso.

Yours respectfully,

C. D. SMITH,
Dean.

Agricultural College, Mich.
June 30, 1904.

REPORT OF THE MECHANICAL DEPARTMENT.

To the President:

I have the honor of submitting the following report of the work done in the Mechanical Department during the year ending June 30, 1904.

The work in the class rooms, drawing rooms, etc., has been conducted as follows:

Fall Term.

Subject.	Hours per week.	Method of instruction.	No. of students.	Year.	Instructor in charge.
Carpentry and wood turning	10	Shop	97	Sub-freshmen	Mr. Krentel. Mr. Baker.
Visits of inspection	4	Visits and lectures	101	Sub-freshmen	Mr. Shedd.
Forging	6	Shop	56	5-yr. freshmen.	Mr. Theadore.
Carpentry and wood turning	10	"	83	4-yr. freshmen.	Kr. Krentel. Mr. Baker.
Chipping and filing	12	"	26	Sophomore	Mr. Leonard. Mr Crawford.
Foundry	12	"	14	"	Mr. Baker.
Forging	12	"	20	"	Mr. Theadore.
Machine shop methods	2	Lecture	66	"	Mr. Leonard.
Metal turning, iron, etc	6	Shop	27	Juniors	Mr. Leonard. Mr. Theadore.
Machine design	6	Drawing	18	"	Mr. Tryon.
Metallurgy	1	Lecture	43	"	Prof. Reynolds.
Experimental laboratory	4	Laboratory	24	Seniors	Mr. Tryon.
Elementary kinematics	2	Lecture	25	"	Mr. Shedd.
Steam engine design	6	Drawing	15	"	Mr Shedd.
Thermodynamics	5	Recitation	24	"	Prof. Reynolds.
Machine tool work	6	Shop	15	"	Mr. Leonard.

Winter Term.

Subject.	Hours per week	Method of instruction.	No. of students.	Year.	Instructor in charge.
Carpentry and wood turning...	8	Shop..............	86	Sub-freshmen..	Mr. Krentel. Mr. Baker.
Carpentry and wood turning*..	10	"	42	Sub-freshmen agricultural.	Mr. Krentel. Mr. Baker.
Forging....................	6	"	55	5-yr freshmen.	Mr. Theadore
Pattern work...............	6	"	74	4-yr. freshmen.	Mr. Krentel. Mr. Baker.
Carpentry and wood turning†..	10	"	43	4-yr. freshmen agricultural.	Mr. Krentel. Mr. Baker.
Machine design..............	6	Drawing...........	55	Sophomore....	Mr. Tryon.
Chipping and filing..........	8	Shop..............	19	"	Mr. Leonard Mr. Crawford.
Foundry....................	8	"	25	"	Mr. Baker.
Forging....................	8	"	15	"	Mr. Theadore.
Steam engine design†	8	Drawing...........	17	Juniors.......	Mr. Tryon.
Machine design†............	8	"	13	"	Mr. Tryon.
Steam boilers..............	2	Recitation.........	27	"	Prof. Reynolds.
Valve gears................	2	Lecture and drawing..	33	"	Prof. Reynolds
Machine tool work...........	12	Shop..............	27	"	Mr. Leonard. Mr. Theadore.
Machine design..............	10	Drawing...........	16	Seniors.......	Mr. Leonard.
Advanced kinematics........	5	"	24	"	Mr. Shedd.
Steam engineering laboratory.	8	Laboratory.........	23	"	Prof. Reynolds. Mr. Shedd.

*Agricultural students.
†Six weeks.

Spring Term.

Subject.	Hours per week	Method of instruction.	No. of students.	Year.	Instructor in charge.
Pattern work...............	10	Shop..............	72	Sub-freshmen..	Mr. Krentel. Mr. Baker.
Chipping and filing..........	6	"	50	5-yr. freshmen.	Mr. Theadore. Mr. Crawford.
Pattern work...............	12	"	68	4-yr. freshmen.	Mr. Krentel. Mr. Baker.
Chipping and filing..........	12	"	32	Sophomore....	Mr. Leonard. Mr. Crawford.
Foundry....................	12	"	24	"	Mr. Baker.
Forging....................	12	"	13	"	Mr. Theodore.
Steam engine...............	4	Recitation.........	56	"	Mr. Shedd.
Machine design..............	4	Drawing...........	56	"	Mr. Tryon.
Machine tools...............	8	Shop..............	7	Junior........	Mr. Leonard Mr. Theadore.
Theory of design...........	2	Lecture...........	14	"	Mr. Tryon.
Strength of materials........	5	Recitation.........	30	"	Prof. Reynolds.
Strength of materials........	2½	Laboratory.........	29	"	Mr. Tryon.
Engineering practice........	2	Lecture	22	Seniors.......	Prof Weil. Prof. Reynolds.
Original design.............	6	Drawing...........	15	"	Mr. Leonard.
Thesis.....................	10	Laboratory.........	16	"	Prof. Weil. Mr. Shedd.

The total number of students enrolled in the Mechanical Department during the year was three hundred and sixty-five (365).

At the beginning of the College year the Board of Agriculture authorized the employment of an additional instructor in this Department and Mr. George Tryon, a graduate of the College in 1903, was engaged as junior instructor in Mechanical Engineering.

Mr. W. W. Wells resigned his position as instructor in June, 1903, after having served the Department very efficiently for a period of two years, in order to enter engineering practice.

Mr. W. R. Shedd, of the class of 1901 of this College was elected senior instructor at the beginning of the present College year.

The arrangement of the work during the past year was somewhat markedly altered, as compared with previous years, through the authorization by the Board of the employment of an additional instructor, as already noted, and the further authorization of an increase in the responsibilities of the assistant professor of Mechanical Engineering, the said changes permitting of greater freedom on the part of the head of the Department in directing the work and in the conduct of practical engineering work.

I am pleased to state that, in my opinion, the work of the Department has been fairly satisfactory during the past year, particularly so considering the number of students handled and the accommodations offered by the Department with respect to room. I desire to express, at this time, my appreciation of the services rendered by my associates during the year, including in this connection Mr. L. F. Jenison, Mr. E. C. Crawford and other special assistants.

A somewhat notable change has been made during the year in the method of conducting work in the Department shops in respect to the employment of a number of skilled mechanics to further the work in hand. The change permits of realizing more fully the plan of having the work designed in the Department drawing room carried out in the shops under the observation of the students interested. It is our intention to provide for the pay of the skilled mechanics employed through the sale of a part of the product of the shops, but we shall, however, while attempting to secure a salable product from the shops, endeavor to keep in mind, at all times, the educational side of shop practice demanded in a technical school.

It would seem unnecessary to make any statement in this report, except as a matter of record, in regard to the need of the Department with respect to additional building space. We believe the need is thoroughly appreciated by all concerned.

Owing to the number of students handled and the consequent necessity of carrying on the Department pay roll several special assistants, a but limited increase can be made yearly in the Department equipment under the present apportionment. The more important additions to the equipment during the past year have been, two engine lathes, one level and one transit.

During the year the writer has carried on a somewhat greater amount of engineering work for the College than usual, particularly in connection with the new central heating, lighting, and power plant now being built. The system of water mains referred to in my last report were completed, in so far as contemplated for the present, during the summer of

1903, and, I believe, in a satisfactory manner. In connection with the engineering work at the College during the past year mention should be made of the satisfactory services rendered by Mr. W. R. Brown, who graduated in 1903 from this College, as inspector of water mains and tunnels.

Respectfully submitted,

CHAS. L. WEIL,
Professor Mechanical Engineering.

Agricultural College, Mich.
June 30, 1904.

REPORT OF THE DEPARTMENT OF ZOOLOGY AND PHYSIOLOGY.

To the President:

I have the honor to submit the following report of the Department of Zoology and Physiology for the year ending June 30, 1904.

There has been no change in the teaching force of the Department during the year, and but little change in the number of classes and the total number of students handled. By special permission of the Faculty a class in Ornithology was organized in the spring term, 1903, to accommodate students who had expected to take Meteorology; but this year it was not deemed expedient to repeat this course in view of the fact that the new course of study provides a term of advanced Zoology for senior students in the fall. This is not necessarily ornithology, but in view of the remarkable growth of interest in birds throughout the State and country at large it would seem to be very fitting that the College should offer a good course in that subject if it can be done without encroaching on other studies.

The lack of laboratory room for the numerous divisions required in physiology, entomology and general zoology is one of the most serious problems confronting the Department. By removing part of the seats in the lecture room and re-flooring the space so obtained the difficulty was partly overcome, but this is but a make-shift involving much carrying back and forth of furniture, apparatus and specimens, and of course the room can be used for but one purpose at a time. In this connection I desire to call attention to the fact that the course in geology is much less effective than it would be if students could be given regular work on minerals and rocks in the laboratory instead of depending, as at present, on the circulation of hand specimens during the lecture hour, or the occasional substitution of an hour of laboratory work for one of recitation. Knowledge of the minerals and rocks that make up the surface of the earth lies at the very foundation of an understanding of soil formation, and without it there is little likelihood that the later courses in soil-physics, plant-feeding, etc., will be of much benefit. Our schedule is now so crowded that it seems impossible to add laboratory work in

subjects which formerly have been given entirely or mainly by lectures, but in my opinion such a change is imperative in the course in geology.

The press of class work during the fall and winter has made it impossible for the Department to do much work at farmers' institutes, but in other ways we have aimed to do our part in the university extension work of the College. The distribution of cases of insects to high schools throughout the State has been almost completed. An offer of such a collection was made to every school on our list of "affiliated schools," and each one which responded within a reasonable time was supplied with a collection. Meanwhile, requests were received from scores of good schools not on our affiliated list and the task of distributing the dozen cases remaining is a somewhat delicate one. Principles, superintendents and teachers alike have shown their appreciation of our efforts, and letters of thanks and commendation have been received from every quarter.

The demand for information on birds has been steadily and rapidly increasing, and during the past year all possible time has been used to complete the bulletin on Michigan Birds which has been in preparation for several years.

At my request the Board, as you are aware, authorized the employment of a stenographer for two or three hours a day during the spring term, and with this additional help I have been able to gather much useful material from correspondents in various parts of the State. Early in July, 1903, I made a somewhat hurried trip through the eastern half of the Upper Peninsula, following the south shore of Lake Superior from Marquette to Grand Marais and spending a day or two at Chatham and in the vicinity of Sault Ste. Marie. The bird notes collected on this trip go far toward filling the most important gaps in our knowledge of the bird-life of this region. It is hoped that a similar reconnaisance of the western half of the Upper Peninsula may be made during the coming summer. During the first week in the present month the writer spent three days in bird work in Washtenaw and adjoining counties and obtained many good field-notes besides inspecting two important bird collections.

The Board also kindly increased the funds of the Department sufficiently to allow the purchase of a camera and lenses suitable for photographing mounted birds, or birds in the field, as well as birds' nests, and some of the pictures obtained will be reproduced for the bulletin. We have secured the hearty co-operation of the members of the Michigan Ornithological Club, as well as the assistance of every wide-awake "bird-man" in the State, and the Division of Biological Survey of the U. S. Department of Agriculture has placed at our disposal the entire series of migration notes from Michigan observers for the past 20 years. With this varied and valuable material at hand the only thing necessary for the preparation of a good work on the birds of the State is a few months of leisure in which to sift, arrange and condense the facts. Much of this work can be done during the summer vacation and it is believed the work can be made ready for the printer during the autumn.

THE GENERAL MUSEUM.

There has been little change in the general museum during the past year except in the way of small but valuable additions to its collections.

As in former years our principal efforts have been towards a more complete representation of the natural resources of our own State,—the addition of good specimens of our own mammals, birds, reptiles and fishes, as well as good examples of the invertebrate fauna of the State,—its insects, shells, worms, etc. Among the more valuable specimens added may be mentioned a fine specimen of muskallonge weighing 16 pounds and a pike or pickerel weighing 18 pounds, caught and presented by Mr. and Mrs. Hugh Lyons of Lansing; a collection of about 50 specimens of gold, silver and copper ores from some of the noted mines of California, Oregon, Idaho, Montana and Colorado (purchased); and a good example (mounted) of the great gray owl from St. Ignace, Mich. The latter completes the list of Michigan owls, giving us at least one example of every species known to inhabit the State. Another important addition to the bird collection is a pair of mounted passenger pigeons, formerly belonging to the late Dr. R. C. Kedzie. This species appears to be on the verge of extinction and the College is fortunate in having several fine specimens.

A good taxidermist was secured for the month of June, principally in order to prepare a few specimens for photographing with the intention of thus obtaining a few good pictures for the bulletin on birds, and advantage was taken of this opportunity to have some valuable but poorly stuffed specimens relaxed and remounted. There is work enough of this kind to keep an expert busy for several months, and we have on hand also a considerable number of unmounted bird skins which should be mounted to fill gaps in the collection.

Respectfully,
WALTER B. BARROWS,
Professor of Zoology and Physiology
and Curator of the General Museum.

Agricultural College, Mich.
June 30, 1904.

REPORT OF THE MICHIGAN WEATHER SERVICE.

Tto the State Board of Agriculture:

I beg to submit the following report of the Michigan Weather Service for the year ending June 30, 1904:

The work during the past fiscal year has been carried forward on lines similar to those of preceding years. The co-operation with the U. S. Weather Bureau has continued.

We have in operation a total number of 121 voluntary observation stations, which with the eight regular Weather Bureau Stations, makes a total of 129 places in Michigan at which meteorological records are maintained.

As a whole, the reports of voluntary observers have been very satisfactory and have mostly been rendered promptly and regularly. The labor of keeping these stations in operation is very great. The great desider-

atum, of course, is to maintain the records continuously. The work of observation is entirely voluntary and as a result the personnel of the voluntary observers is quite changeable. The observer has nothing but interest in the work and public-spiritedness to prompt him to take the observations, and when it is remembered that a good record requires a daily reference to the instruments, it can be easily understood that the work, at times, becomes onerous; nevertheless, splendid results have been obtained and a very large measure of credit is due to Michigan's very excellent corps of voluntary observers.

The equipment remains the same and is of standard type as compared with that in use in other states.

The meteorological data secured through the co-operation of these voluntary observers is constantly finding a wider field of usefulness and becoming more valuable to the people every year as is evidenced by the increasing demands on this office for information.

The Weekly Climate and Crop Bulletin which has been published during the planting, growing and harvesting seasons, continues in favor with the public and is published in condensed form by the metropolitan press and a large part of the smaller newspapers. The information it contains is considered very reliable and recent. We have, at present, nearly 700 crop correspondents who report weekly for this Bulletin. Their reports are mailed so as to reach this office Monday noon and by Tuesday afternoon the Weekly Bulletin has been printed and mailed.

The Monthly and Annual publications, which contain statistical meteorological data that is reported by the voluntary observers, have been published in the same style and form as in previous years. The data is all displayed in detail and tabulated homogeneously with the reports published in other states in the Union so that it can be readily compared with any other part of the country. These Monthly and Annual Reports are widely sought for.

The forecast dissemination outside of the newspapers is accomplished principally through the medium of forecast cards sent out from 53 distributing centers and by rural telephone service from rural telephone exchanges to about 5,000 rural subscribers. The present rapid extension of rural telephone service is opening up a new medium for the dissemination of our forecasts that is very expeditious and satisfactory. As rapidly as possible I am arranging to supply rural telephone exchanges with the daily forecasts and special warnings on the condition that they be furnished promptly, regularly and impartially to rural subscribers. These conditions the telephone people are glad to accept because it makes the telephone more desirable to the farmer.

Quite a number of voluntary observation stations have been inspected, but I was unable to make as many inspections as usual on account of lack of funds and time. The inspection of voluntary observation stations is considered a very important feature because it promotes better work on the part of the observer and in many cases corrects exposure of instruments and mistaken ideas and reading and making observations that cannot be satisfactorily accomplished by letter; it also tends to bring the voluntary observer into closer and more harmonious touch with the Service.

To resume, I would say that the mailing list of the Weekly Crop Bulletin is about 1,300, of the Monthly Bulletin about 1,100 and of the

Annual about 1,100. Daily forecasts are displayed in about 900 post-offices and 2,000 other public places; by rural mail carriers we are reaching about 8,000 farmers and by rural telephone about 5,000.

Very respectfully,

C. F. SCHNEIDER,
Section Director.

Grand Rapids, Mich.
June 30, 1904.

REPORT OF STATE INSPECTOR OF NURSERIES AND ORCHARDS.

Hon. C. J. Monroe, Président State Board of Agriculture:

Sir—During the past year in addition to the routine work of inspecting the nurseries of the State and attending to the office correspondence, it has been thought advisable to spend considerable time inspecting the orchards in sections where the San Jose scale has appeared and where serious losses have occurred from the attack of "little peach."

As required by law, all the nurseries in the State and those in other states which were known to have agents in Michigan, were during the early part of July informed of the importance of paying their license fee and filing the usual nursery bond for the year ending July 31, 1904, on or before August 1, 1903. An unusually large number responded promptly, and by the first of August, a majority had complied with the requirements of the law so far as securing a bond was concerned. The work of inspecting the nurseries was then taken up and was practically completed before the first of October, most of those remaining uninspected at that date, being of small size or consisting of small fruit plants only.

As it was known that the San Jose scale had appeared in many new sections in the State, it was feared that it might be discovered in a number of the nurseries, but it was found in no new places and, in one of those found to be infested in 1902, no scale was discovered when the nursery was inspected in the fall of 1903. The infested block was dug the previous fall and as there was no other stock near it, it was not a difficult task to eradicate the scale in this nursery. As in previous years, all nursery trees found to be infested were ordered destroyed and the trees remaining in the nurseries were fumigated with hydrocyanic acid gas. In a few cases where the San Jose scale was known to be present within a half mile of the nursery, the owners of the nurseries were required to fumigate their stock when dug for sale.

The nursery stock inspected was comparatively free from dangerous insects and more injurious fungous diseases. The crown-gall was quite troublesome in two nurseries and, as is usually the case, was occasionally found upon the trees in nearly all of them. As in previous years, the nursery men were required to destroy all trees upon which the gall was found.

While a considerable amount of orchard inspection was done in other counties, it was confined particularly to Berrien, Van Buren, Allegan, Ottawa, Kent, Muskegon and Oceana counties. As the "little peach" had destroyed thousands of trees in western Allegan county, a special deputy, Mr. H. G. Welch of Douglas, was appointed to co-operate with the local yellows commissioners in the inspection of the orchards in his township. Special attention was paid to a tract containing some seven square miles, south of the village of Douglas. The peach orchards upon this area are somewhat isolated from the other peach orchards of the vicinity and an endeavor was made to ascertain what the effect upon the spread of the disease would be if all infected trees were promptly removed. The Bureau of Plant Industry of the U. S. Department of Agriculture had been for several years studying this disease and asked to be allowed to co-operate in the experiment. As they furnished one or two observers, it materially aided in carrying out the work and lessened the expense to a marked degree. The orchards in the tract referred to above were gone over three times during the season and every tree which showed any signs of the presence of the disease was at once destroyed by the owners who gladly co-operated in the work. It is proposed to continue the prompt eradication of all trees affected with this disease upon this tract. By doing this, it is hoped to obtain some light upon the effect of eradicating trees infected with "little peach." While there have been numerous instances where it has been practiced for a series of years, and where it has seemed to be beneficial, there have been few, if any cases, where trees which were attacked by this disease upon large areas have been removed. It is hoped that the experiment will result in material benefit to the parties whose orchards have been infected and that the information secured will be of value to many others.

In addition to the time spent by Mr. Welch in the orchards in his vicinity, he also visited Muskegon and Oceana counties and after finding the "little peach" seriously injuring the trees in many orchards, he interested the local yellows commissioners and not only informed them of the methods of detecting its presence but regarding the importance of the prompt removal of the trees.

While the San Jose scale is far from being generally distributed, it has made its appearance in several places in each of the counties in the southern part of what is known as the "peach belt." Visits to that section showed it to be present in a number of orchards and in many cases the trees were practically dead although the owners did not know of the presence of the disease. A large number of orchards in the infested sections were examined during the early spring and the work was continued in the vicinity of South Haven and Benton Harbor during the months of May and June. Although only a small per cent of the trees inspected were found to be infested, its presence was detected in a considerable number of orchards and steps were at once taken to prevent its further spread. Except in a few instances, the owners of the infested trees merely needed to be informed of the presence of the scale and instructed as to the best method of treating, and in no case was it found necessary to prosecute the owners in order to secure the spraying of the trees.

There are now upon the statute books of Michigan three laws which

relate to the inspection of trees infested with dangerous insects and diseases. The first of these is known as the yellows law and its enforcement is in the hands of township commissioners. The second which was passed in 1897 is commonly spoken of as the "spraying law." Its enforcement is placed in the hands of special township commissioners, although in townships where yellows commissioners have been appointed they are made *ex officio* commissioners under this law. The third law is the nursery and orchard inspection act. This deals primarily with the licensing of the nurserymen and the inspection of nursery stock. The State inspector of nurseries and orchards which office is provided for under this act, has authority also to inspect orchards supposed to be infested with dangerous insects and diseases. While he has abundant authority to secure proper attention to nursery stock found to be infested with dangerous insects or diseases, the law is not sufficiently explicit regarding its enforcement when orchard trees are infested and the law would be made much more effectual by giving to the State inspector the same authority as is conferred upon the township commissioners by the yellows and spraying laws. It was supposed that such authority was given by the act, but during the past year the attorney general has decided to the contrary.

While the "yellows" and "spraying laws" are prepared upon the same general plan, they differ in a number of important particulars and as their enforcement may be placed in the hands of the same commissioners, it would seem advisable that the two laws be combined in one.

At the annual meeting of the State Horticultural Society in January, 1904, the matter was brought to the attention of the members present and a special committee on legislation, of which the writer was made chairman, was appointed to secure such changes as might be thought necessary.

In the work of nursery and orchard inspection the following deputies have been employed from two weeks to three months each: John M. Rankin, inspecting orchards for canker worms and San Jose scale; T. A. Farrand, inspecting orchards and nurseries; E. W. Allis, inspecting nursery stock, and R. J. Stahelin, inspecting small fruit plants at Bridgman.

The following is the list of nurserymen who took out licenses to sell nursery stock in Michigan during the past year. The first list includes such firms as grow more or less of their stock and whose premises were inspected. The second list contains the names of Michigan dealers in nursery stock, or the firms which purchase from other nurseries the stock they sell, and the third contains the list of nurseries in other states which have agents in Michigan:

MICHIGAN NURSERIES LICENSED IN 1903-4.

Allen, R. E.	Paw Paw
Allen, W. E. & Co.	Kalamazoo
Alway, Edward	Gobleville
American Nursery Co.	Kalamazoo
Babcock & Nash	Bridgman
Baldwin, C. E. & Co.	Augusta

Baldwin, O. A. E.	Bridgman
Baker, Chas. H.	Plainwell
Bigelow, J. N.	Bangor
Boal, E. A.	Hinchman
Bragg, L. G. & Co.	Kalamazoo
Briscoe, Joseph A.	Highland Park
Brooke, F. W.	Ithaca
Central Michigan Nursery Co.	Kalamazoo
Clark, D. H.	Holland
Cross, James A.	Spring Lake
Culver, O. B.	Colon
Curtis, L. T.	Flint
Cutler & Hamilton	Benton Harbor
Davis, Geo. B.	South Haven
Dean, Geo. N.	Shelbyville
Dow, H. C.	Spring Grove
Dressel, Gilbert L.	Frankfort
Dunham, E. W. & Co.	Stevensville
Emmanuel Missionary College	Berrien Springs
Essig, W. W. & Co.	Detroit
Ferrand, E. & Son	Detroit
Flansburgh & Pierson	Leslie
Goodell, E. W.	Mayville
Greening Bros.	Monroe
Green, A. W. & Son	Grass Lake
Gustin, C. F.	Adrian
Haines, J. W.	Eaton Rapids
Hamilton, A. & Son	Bangor
Hammond Seed Co.	Bay City
Havekost, G. H.	Monroe
Hawley, E. & Son	Hart
Herbst, Wm. G.	Maybee
Husted, N. P.	Lowell
Ilgenfritz, I. E. & Sons Co.	Monroe
Ilgenfritz, E. C.	Monroe
Jaquay, Irving, Co.	Benton Harbor
Jeffrey, Jr. James	Bronson
Jeffrey, Sr. James	Kalamazoo
Johnson Bros.	Snowflake
Joy, C. F.	Bloomingdale
Keirnan, T. W.	Fennville
Kellogg, R. M.	Three Rivers
Kerry & McClave	Benton Harbor
Knight, David	Sawyer
Lake Shore Nursery Co.	St. Joseph
Lampson & Rood	Covert
Leathers, W. J. & Co.	Breedsville
Lewis, A. E. & Sons, R. F. D.	Lowell
Link, W. J.	Gobleville
Malone Bros.	Lamont
Maudlin, E.	Bridgman
McKee, H. R.	Coloma
McKegan, F. D.	Plainwell

Michigan Nursery Co....................Monroe
Morley & Dyer....................Benton Harbor
Morrill, Roland ....Benton Harbor

Negaunee Nursery ....Negaunee
Nelson, J. A. & Son....................Paw Paw
Newaygo County Nursery Co....................Fremont
Northwestern Nursery Co....................Muskegon

Parker, E. E....................Lacota
Paw Paw Valley Nursery Co....................Coloma
Pearce, P. D....................Grand Rapids
Pomona Nurseries, R. F. D....................Ada
Prater, Geo. E. Jr....................Paw Paw

Rose, Paul ....Frankfort

Sheldon & Son, P. B....................Litchfield
Singer, W. H....................Lapeer
Speyers, Chas. M....................Willis
Spielman Bros. ....Adrian
Stone & Son, John....................Hillsdale
Sweet, L. H....................Carsonville

Warner, Louis ....Glenn
Watterson & Son, W. J., R. F. D....................Ada
Webb, D. S. & Co....................St. Joseph
West Michigan Nurseries....................Benton Harbor
Weston, A. R. & Co....................Bridgman
Whitten, C. E....................Bridgman
Wilber, M. B. & Son....................Mecosta
Wise, Ralph, R. F. D....................Plainwell
Wooll & Tillotson....................Elsie

MICHIGAN DEALERS IN NURSERY STOCK.

Augustine, L. D....................St. Joseph

Bagley, W. D....................Old Mission
Bassage, A. W., R. F. D. 1....................Fennville
Bond, I. J....................Athens
Booske, Adolph ....Marine City
Boyd & Skinner....................Central Lake
Braman, O. W., R. F. D. 4....................Grand Rapids

Campbell, A. H....................Mattawan
Co-operative Sand and Savings Co....................Beaverton

Danzer, Frank, 26 Miami Ave....................Detroit
Davis, S. B....................Jackson
Davison Nursery Co....................Davison

Filer, A. C....................Sault Ste. Marie
Ford, Geo. W....................Saranac

Harper, C. W....................Lawton
Healy, William ....Bloomingdale

James, Arthur M....................Midland

Kimball, D. S., 47 Aurelia St....................Detroit
Knapp, Chas E....................Lawton
Knapp, W. F....................Monroe

Markle Nursery Co., H. F. Markle....................................Holland
Mosier, C. H..Paw Paw

Oregon Nursery Co...Detroit

Pearson, D. S., 173 Hastings St.............................Grand Rapids

Sessions, C. E...Ionia
Shepard, Andrew G..Paw Paw
Sonter, Geo. H...Holland
Stark, T. J..Oxford
Strittmatter, Adolph, 488 Chene St...............................Detroit

Taplin, Stephen, West Fort St......................................Detroit
Taylor, Frank J...Hartford

Washington Nursery Co...Detroit

FOREIGN NURSERIES.

Albaugh Nursery Co.......................................Phoneton, Ohio
Allen Nursery Co..Rochester, N. Y.

Bogue, Nelson ....Batavia, N. Y.
Bohlender, Peter & Son...................................Phoneton, Ohio
Bryant Bros. ....Dansville, N. Y.

Costich Co., G. A..Rochester, N. Y.
Charlton Nursery Co......................................Rochester, N. Y.
Chase, Chas. H...Rochester, N. Y.
Chase, R. G. Co..Geneva, N. Y.
Clark Nursery Co..Waterloo, N. Y.
Cole, W. B..Painesville, Ohio

Day, John ....Fremont, Ohio

Empire State Nursery......................................Waterloo, N. Y.

Franklin Davis Nursery Co., Baltimore and Poca Sts..............Baltimore, Md.

Graham Nursery Co..Rochester, N. Y.
Grover, F. E. & Co...Rochester, N. Y.

Hawks Nursery Co..Rochester, N. Y.

Jewell Nursery Co..Lake City, Minn.

Knight & Bostwick...Newark, N. Y.

McKay Bros. ....Pardeeville, Wis.
Mayfield Nursery Co...St. Paul, Minn.

North Jersey Nurseries...................................Springfield, N. J.

Olver Bros. ....Rochester, N .Y.

Peirson Bros (Maple Grove Nurseries)....................Waterloo, N. Y.

Sherwood, Elmer ....Odessa, N. Y.
Spaulding Nursery and Orchard Co...........................Spaulding, Ill.
Stark Bros. Nurseries and Orchards Co.......................Louisiana, Mo.

Ullyette Bros. ....Dansville, N. Y.

Western New York Nursery Co....................................Rochester, N. Y.
Whitney, G. W. & Co..Dansville, N. Y.
Willett, Eugene ....North Collins, N. Y.

Respectfully submitted,
L. R. TAFT,
State Inspector of Nurseries and Orchards.

Agricultural College, Mich.
June 30, 1904.

SEVENTEENTH ANNUAL REPORT

OF THE

EXPERIMENT STATION

OF THE

STATE AGRICULTURAL COLLEGE OF MICHIGAN

UNDER THE HATCH ACT

FOR THE

YEAR ENDING JUNE 30, 1904.

For members and organization of the State Board of Agriculture in charge of the Station and list of officers, see page nine of this volume.

EXPERIMENT STATION.

REPORT OF SECRETARY AND TREASURER.

The following account shows the receipts and expenditures of the Experiment Station for the year ending June 30, 1904:

		Dr.	Cr.
July 1, 1903—To	balance on hand	$2,427 68	
July 10, 1903	received from U. S. Treasury	3,750 00	
Oct. 12, 1903	received from U. S. Treasury	3,750 00	
Jan. 8, 1904	received from U. S. Treasury	3,750 00	
April 16, 1904	received from U. S. Treasury	3,750 00	
June 30, 1904	license fees on 107 brands commercial fertilizers	2,140 00	
	miscellaneous receipts	249 55	
	farm receipts	2,376 73	
	from State appropriation, So. Haven.	500 00	
	from State appropriation for U. P. Experiment Station	5,000 00	
	U. P. Experiment Station, receipts	290 78	
	South Haven Experiment Station receipts	831 24	
June 30, 1904—By	disbursements as per vouchers filed in the office of the State Auditor General	....	$24,934 11
June 30, 1904	balance on hand	....	3,881 87
		$28,815 98	$28,815 98

From thirty-five to forty thousand copies of station bulletins are now issued, and the demand is increasing as farmers learn of their value. Several press bulletins have been issued and special information in bulletin form has been sent out by the station.

DISBURSEMENTS ON ACCOUNT OF U. S. APPROPRIATION.

Salaries:		
Director and administrative officers, No. employed 6.	$2,427 00	
Scientific staff, No. employed 7	3,670 30	
Assistants to scientific staff, No. employed 3	657 94	
		$6,755 24
Labor:		
Monthly employes, 2; average rate, $45.00	$1,080 00	
Monthly, weekly, daily and hourly employes	2,356 22	
		3,436 22
Publications:		
Half tones, mailing list, etc	$67 94	
		67 94
Carried forward		$10,259 40

Brought forward		$10,259 40
Chemicals:		
Chemical supplies		278 85
Seeds, plants and sundry supplies:		
Agricultural	$197 02	
Entomological	52 66	
Horticultural	36 98	
Miscellaneous	533 07	
		819 73
Tools, implements and machinery:		
Repairs	$16 67	
New purchases	30 00	
		46 67
Furniture and fixtures:		
One desk	$26 00	
One case	19 00	
One desk	26 00	
Sundry fixtures	9 50	
		80 50
Scientific apparatus:		
Sundry items	$490 04	
		490 04
Live stock:		
Horses	$360 00	
Cattle	884 38	
Sheep	259 00	
		1,503 38
Traveling expenses:		
In supervision of station work	$31 62	
For other purposes connected with station work	238 82	
		270 44
Building and repairs		6 77
Postage and stationery		520 46
Freight and express		292 42
Feeding stuffs		99 69
Library		293 99
Fertilizers		27 18
Contingent expenses		2 88
Heat, light and water		7 60
Total		$15,000 00

DISBURSEMENTS OF EXPERIMENT STATION—MONEYS OTHER THAN RECEIVED FROM UNITED STATES TREASURER.

Salaries	$1,710 50	
Labor	4,966 14	
Publications	5 05	
Postage and stationery	313 25	
Freight and express	147 96	
Heat, light and water	14 95	
Chemical supplies	87 70	
Seeds, plants and sundry supplies	1,320 29	
Fertilizer	87 45	
Library	47 44	
Tools, implements and machinery	40 67	
Furniture and fixtures	34 64	
Scientific apparatus	34 04	
Building and repairs	105 00	
Traveling expenses	210 30	
Live stock		
Feeding stuffs	808 73	
		$9,934 11
Balance on hand		3,881 87
Total		$13,815 98

ANNUAL REPORT OF THE DIRECTOR AND AGRICULTURIST.

To the President:

During the year ending June 30, 1904, there have been issued by the Experiment Station the following bulletins:

No.	Title.	Author.	Dept.	Pages.
211	Breakfast Foods	F. W. Robison	Chemical	25
212	Seed Testing for Farmers	B. O. Longyear	Botanical	11
213	Vegetables and Small Fruits	L. R. Taft and M L. Dean.	Horticultural	12
214	Tomatoes and Potatoes	L. R. Taft and M. L. Dean.	Horticultural	10
'215	Farther experiments with Sugar Beets	C. D. Smith	Agricultural	19
216	A Brief Review of Special Bulletins, 24, 25 and 26	C. D. Smith		
	Special Bulletins:			
20	Report of Upper Peninsula Sub-station for the years 1901 and 1902	C. D. Smith and L. M. Geismar	Agricultural	52
21	Cheese Problems	John Michels	"	10
22	The Crop of Corn	J. A. Jeffery	"	15
23	A Preliminary note on the associative action of bacteria in the souring of milk and other milk fermentations	C. E. Marshall	Bacteriological	8
24	Insects injurious to fruits	R. H. Pettit	Entomological	79
25	Fungous diseases of fruits	B. O. Longyear	Botanical	68
26	Spraying Calendar	L. R. Taft	Horticultural	
27	Report of South Haven Sub-station	T. A. Farrand	"	36
28	Report of Upper Peninsula Sub-station	L M. Geismar	Agricultural	
29	The associative action of bacteria in milk	C. E. Marshall	Bacteriological	

Notwithstanding the frequent and necessary pruning of the mailing list to insure the removal of names of persons who no longer need or desire our bulletins, it is constantly increasing. The total number of names approaches forty thousand. The practice of printing as special bulletins, such articles as are of primary importance to certain sections of the State or to people engaged in certain industries, still continues and with this practice goes the further practice of publishing as bulletins not educational articles but results of experiments and reports of investigations made by members of the staff. The bulletins are printed by the College without charge to the regular station funds.

I am glad to report that there have been few changes of importance in the working force of the station during the year. R. H. Pettit was made a member of the council at the beginning of the year. M. L. Dean, who had for several years rendered efficient service as assistant in horticulture, in November, 1903, left the station work to make a collection of tree fruits for the Exposition at St. Louis. He brought to the work of assistant at this station a long experience in growing small fruits as well as tree fruits and vegetables at Grand Rapids and elsewhere. He was thoroughly trained in practical horticulture and the station meets with a serious loss when he leaves it. By reason of the fact that so few changes have taken place in the working force of the station the

investigations have been continued without changes either in aim or method to interrupt the successful prosecution of the work.

No conspicuous changes have been made in the equipment of the station.

The report of the superintendent of the Upper Peninsula Experiment Station shows that the year 1903 made possible the successful growing of few crops in that northern latitude by reason of excessive wetness in some months and a period of drought in others. The late frosts of spring and the early frosts of fall continued during this season and made hazardous the growing of such garden crops as strawberries and such fall crops as corn and beans. While the present climatic conditions continue the resident of the Upper Peninsula will be compelled by these unfortunate frosts to devote his attention to the production of such crops as the frosts will not seriously injure.

Some notable improvements have been made at this sub-station. The land south of the house on both sides of the creek has been cleared of stumps and has been drained. This work has involved a large expense but was absolutely necessary both for the appearance of the station and for the continuation of the plot experiments.

No changes are noted in the equipment of the sub-station at South Haven. The trees are now in full bearing and the records of yields are invaluable to the fruit growers along the shore of Lake Michigan.

The reports of the several divisions of the station work filed herewith will exhibit the work accomplished and planned.

The horticultural work of the station is embarrassed by the fact that the horticulturist finds himself burdened with other duties entirely unconnected with the station, which must necessarily occupy the bulk of his time. It is particularly unfortunate that in a State like Michigan, where the fruit industry is so prominent in the list of agricultural resources, that the organization of the station does not permit of an arrangement by which one trained man may devote his entire time to experiments and investigations in this most promising field. Just now the fruit growers are environed by so many difficulties, their orchards are troubled by so many diseases, the lack of fertility of the soil is bringing about sterility and economic conditions, the inability to get at reasonable prices suitable and intelligent labor, combined with the competition from other fruit growing sections, that it seems to be incumbent upon the station to help the fruit grower by every means within its power. When the fortunate time shall arrive wherein one man may devote his entire time and energy to this field then the fruit interests of the State will receive due recognition and a still inadequate proportion of the funds of the station.

During the winter the investigation as to the relative merits of silage and dry corn fodder was continued, using a carload of steers purchased in Chicago, fed through the winter and sold in May. While Michigan will not in the immediate future become a beef-producing State, still so large a number of steers are fattened annually within her borders that the question of the proper method of handling the corn crop to secure the greatest profit in beef production is one of prime importance. It is impossible to present to the man who has no experience in experimental work the difficulties that environ a question of this kind. If all steers were alike, we should have a measure which would be uniform through-

out the whole experiment, but one steer differs from another very materially, not alone in the amount of feed he is able to consume, but in the results that are forthcoming from the feeding of a given amount of food. One steer, from the consumption of one hundred pounds of silage with a given complement of grain feed, makes five pounds of gain. Another steer of the same weight and, for that matter, of the same type makes but three pounds of gain from the same quantity of feed. The per cent of digestibility of the different foods will be the same in the two animals but the nutritive effects of the feed will be vastly different. Unfortunately we have no measure of the nutritive effects in the two animals until the experiment itself has been tried and the results noted. For these reasons it has been necessary to repeat these experiments over and over for four succeeding years, and even now the station hesitates to print the results lest the apparent differences are due to causes which the experimenter cannot recognize, rather than to the conditions which have been purposely varied.

The introduction of the industry of sugar production has brought with it a supply, almost unlimited in amount, of a feeding stuff of unknown value, namely, beet pulp. The investigations aiming to determine the value of this material in terms of other and better known feeding stuffs, have been conducted during the past year, both with sheep and cattle. The results are ready for publication and will appear in Bulletin No. 217. It seems, to the most casual observer, unfortunate that at present the bulk of the beet pulp produced in the State is either wasted or shipped outside of its borders.

But one bulletin relating to the dairy industry was issued during the year. This was Special Bulletin No. 21. Since Michigan is primarily and justly a dairy State, the work along these lines will be further developed in the future as it has been in the past. Arrangements are making whereby more dairy cows will be kept to be used partly in station work for the testing of the relative values of feeding stuffs and for such other investigations as time may make pertinent and valuable.

A flock of goats was purchased early in the year to test their value in clearing land of brush and also to find out something about their habits when closely confined. The results have never been favorable to the project of keeping Angora goats on our Michigan farms.

The work with sugar beets was continued along much the same lines as in the previous years. The series of investigations concerning the proper and most profitable width of rows was concluded, it being practically demonstrated that 24 inches would produce as heavy a tonnage and as rich beets as 18 inches, thus reducing by a third the cost of thinning. It was shown also that spraying would reduce the amount of leaf spot, although it was not demonstrated that spraying to prevent this disease was profitable. In the matter of fertilizers no definite results were reached nor were definite results possible. It was shown that on the soils on which the experiments were tried, nitrate of soda produced a profitable increase in tonnage. As far as phosphoric acid is concerned some of the soils showed a lack of that ingredient, while others did not. All soils seem to need potash, to at least a limited extent. The injurious effect of growing beets after beets for three successive years are still further demonstrated by the results of last year. In

almost every case the yield of the subsequent growths was materially lessened by this abuse of the land. This statement makes no war against raising beets where they occupy a suitable place in the rotation. Other considerations point most emphatically to the necessity of the adoption on the part of farmers of a rotation in which beets shall be a regular factor. It seems to me more and more evident as years go by that in America the progress of beet growing depends upon getting the farmers to adopt a rotation in which beets shall be a regular and constant factor, a factor as much expected and depended upon as wheat or corn or clover. Then the factory will have its regular, uninterrupted supply without the necessity of this eternal solicitation on the part of paid agents of the factory. Then, too, the farmer will make a study of the business, consciously or unconsciously, as he has of wheat and corn and will adopt the methods which experience teaches to be most profitable and economical for the production of the crop. With Bulletin No. 215 the preliminary work with sugar beets is brought to a close. The utility of further tests either in the direction of comparison of varieties or of work as to distance apart of rows or of fertilizer tests does not seem to be apparent. Should such work be continued it will necessarily be at points away from the station because of the impossibility of finding on the station grounds suitable soil on which to carry on the work. A constant watch will be kept over the beet fields in the State to take up at once the study of any new pests that may appear or any of the older pests imported from the old country.

The claims made by seedsmen and interested parties as to the value of soy beans, cowpeas, and vetches, made it wise to take up a systematic and careful study of these legumes. Variety tests in such matters are of but little value since the variety favored by the peculiar climatic conditions of one year may be hindered by those for the year following. For instance, where the season is long and the late frosts of spring are absent with perhaps an autumn going into October without killing frosts, the medium green soy will furnish not only the largest amount of forage but the greatest yield of seed. In such a season the Ito San will give the smallest yield of both forage or grain. On the other hand, where the frosts are late in the spring and come early in the fall, the medium green soy would mature no seed, while the Ito San might ripen its seed perfectly. However, variety tests have been begun and will be continued for two years more at least before results are published, the work having already covered two years. These new crops are used for two purposes, to supply feed, either forage or grain, to live stock, and to plow under as green manure. To date our work has lain along the latter line. Plots were set aside on which were sown either soy beans or cowpeas or vetches, and for comparison clover and certain of the cereals. These plots were duplicated on an adjoining area. From one set of plots crops were harvested, from the other they were plowed under entire. Both sets of plots were plowed under in the fall of 1903 and sown to wheat. The winter was so severe as to kill the wheat, hence the plots were harrowed up in the spring of 1904 and sown to oats.

Not content with this examination of the question on a large area, small plots of each of the legumes were dug up, the tops and roots weighed and analyzed separately. The results are about ready for pub-

lication but await confirmation by another year's experience before they are issued. Calculating the results to acre units it was found that the medium green soy when inoculated, that is when the roots bore the normal numbers of bacteria-infested nodules, returned per acre 152.29 pounds of nitrogen and 100.89 pounds of potash, but when uninoculated, that is when there were no nodules on the roots, the return per acre was but 63.12 pounds of nitrogen and 67.84 pounds of potash. The cowpeas, New Era, inoculated, returned 61.90 pounds of nitrogen per acre and 77.20 pounds of potash. The vetch, 77.10 pounds of nitrogen and 63.12 pounds of potash. The samples of these crops were taken September 23, 1903, the second crop of clover was growing on an adjacent plot. The crop was an average one and similar samples of tops and roots taken and analyzed and, as in the other cases, the total content of nitrogen, phosphoric acid and potash determined. This clover crop returned 51.47 pounds of nitrogen per acre and 36.18 pounds of potash. Of course, it is to be remembered in this connection that there are two crops of clover per season to be considered, whereas there is but one crop of the other legumes. These preliminary results are certainly very interesting and demand a careful and thorough study in this season and the next. Work was begun last year, investigating the relation of various factors to the abundance of the nodules on the roots. Quite contradictory evidence was produced. In one case an abundance of nitrogen seems to prevent the formation of the nodules, in another it seems to encourage it, so the presence of potash in large quantity in one case seemed hostile and in another favorable to the presence of the nodules. Inoculation with soil from a field which had borne soy beans was effective in one case and not effective in another. There is much work laid out for the station on these topics before any decisive and final verdict can be rendered. Cooperative experiments in various parts of the State were planned in the spring of 1904, and are in operation at the date of this report.

For several years experiments have been conducted aiming to answer live questions regarding the growing of alfalfa. Much is known concerning this crop but much that is written concerning it in the rural press is untrue. So much depends upon the character of the season, that it is not alone unsafe but is worse than that, it is false and misleading to publish results of the work of a single season. The alfalfa sown in the spring of 1903 is making a vigorous growth and the first crop was harvested June 9, 1904, the alfalfa then knee high and just beginning to blossom. Possibly because the season of 1903 was wet the alfalfa sown with a nurse crop was the freest from weeds and the most vigorous of any, excelling in these respects adjacent plots sown without a nurse crop but run over with a mower two or three times during the season to prevent weeds going to seed. Parallel trials on farms away from the station show that the alfalfa was, to a great extent, killed by the coat of ice which covered the ground in the late spring of 1904 and were it necessary to render a verdict at the date of this report it would have to be that alfalfa was not a safe crop for the farmer in Michigan, although in certain protected localities it withstood the asperities of an adverse winter.

The farm department of the station is carrying on at no inconsiderable expense work planned by Prof. Crozier and the Directors in 1894, on

plots laid out and under-drained by Director Eugene Davenport, now of Illinois. This work will furnish nothing for publication until 1905. Adjacent plots are treated with different rotations or with different combinations of commercial fertilizers. Plot one, for instance, has borne wheat and clover alternately for a long series of years and will continue to do so until 1905. The adjacent plot bears the rotation wheat, clover, potatoes, still another plot a four-year rotation, another has twenty loads of barnyard manure to the acre each year, the next an equivalent of this manure in commercial fertilizers. In 1905 the whole area will be planted to corn, the next year sown to oats, the next to wheat and the next to clover to test the final effect of the treatment on the productivity of the soil.

Concerning the use of vetches for any purpose upon the Michigan farm something ought to be said in regard to the danger of this legume becoming a bad weed. This much is true, wherever vetches have been sown on the station plots there have appeared occasional plants which have presented in due time their beautiful blue flowers and, unless they are harvested before the formation of the vetch seed, the latter becomes an integral part of the harvest, carrying forward the vetch as a weed into the next crop to be grown from the given seed. In wheat it has proven on the farm, as it has on the area east of Howard City, a bad and really dangerous weed. The vetch seed is about the same size as a kernel of wheat and has about the same specific gravity, rendering it quite impossible to either screen out or winnow out the vetch seed from the seed wheat. As a result, the station has to be at a considerable expense each year in the removal of the growing vetch from the crops.

Prof. Longyear, the botanist of the station, made a careful botanical study of the vetch resulting in the outline of a key, by the use of which the farmer, although ignorant of botany, may be able to tell to which class a given sample belongs. This is a matter of prime importance, because under the name of hairy vetch there are sold by the seedsmen a great variety of vetches, some utterly worthless and some very useful.

The beginning of the selection and breeding of corn for higher content of protein was made in the period covered by this report. The introduction of varieties from Illinois or further south proved as was to be expected, entirely abortive of results. The corn did not mature sufficiently to perpetuate itself and where, in one or two cases, it did mature enough to form kernels that would germinate the effect of the change of climate on per cent of protein was sufficiently great to render the further work with the foreign varieties nugatory. Michigan grown seed was selected and from the results of the chemical selection those ears containing the highest protein in the spring of 1904 were used for seed that spring. By combining the physical appearance of the ear, its cylindrical form well filled out at butt and tip, with the results of chemical analysis, we hope to increase the per cent of protein in the corn without lessening the yield per acre. No revolution will be attempted but a gradual evolution of better strains of well known varieties. The advice so often given farmers to change their seed with no definite object in view is entirely wrong. The hope of the Michigan farmer in the matter of corn is to evolve better strains of existing varieties rather than to introduce a radically superior variety from some distant source.

In wheat attempts have been made along the same line as in corn to improve the crop in gluten content. Prof. Jeffery is selecting the wheat for its gluten content, depending to some extent on the color and physical appearance of the grain as well as upon its chemical analysis, while the farm department of the station is cooperating by selecting heads that contain a large number of kernels produced on straw of the right height, stiffness and vigor. No attempts are made at cross fertilization, a process which is not promising.

There has recently been presented to the station a problem of more than usual importance and at the same time one very difficult of solution. The cattle on the more sandy areas of the Lower Peninsula seem to be afflicted with a disease characterized by loss of appetite, emaciation and final death apparently from starvation. Last year cattle were brought down from West Olive, where the disease prevails, for treatment at the College. They were given tonics and plenty of succulent food. Their recovery was rapid and dated almost from the day of their arrival at the College, appetite returned and their gains were almost phenomenal. This plan was again adopted in 1904 and several head of cattle were again brought to the College. No treatment other than sensible feeding with succulent food was given but the cattle, when able to stand on their feet, have gained in flesh and thrift with every promise of permanent recovery.

Investigations carried forward at the localities where the disease exists seem to point to the conclusion that the disease is confined very largely, if not entirely, to sandy soils and the symptoms and history give rise to the question as to whether there is a specific disease other than a chronic irritation of the digestive tract due to imported feed, usually confined to very coarse feed without a sufficient supply of protein or possibly without a sufficient supply of some of the ash ingredients needed in the animal anatomy. It is possible that the corn and grass grown upon some sections of the State may be deficient in some element quite essential to the health of the animal, such for instance as protein iron. The chemist of the station is at work upon this phase of the problem studying the composition of the water in the soil and of the feeding stuffs grown on the farms where the disease prevails. The work is taken up in connection with the State Live Stock Sanitary Commission which has aided in the investigation in every possible way. The bacteriologist is investigating the possibility of some organism in the blood which may account for the emaciation. The botanist has gone over the ground carefully to find some weed of a poisonous quality to which the disease may be attributed. So far his examinations have found no possible cause of the disease in the flora of the affected regions. The veterinarian has also carried on considerable work studying the life history of intestinal parasites of lambs comparing the various methods of treatment.

The bacteriologist has wisely confined his attention to the germs in milk, since the bulk of his time has necessarily been devoted either to the completion of a building and moving into it or to teaching and arranging the various laboratories and rooms for his classes. His work in discovering the inter-relation of groups of bacteria apparently opposed to each other as to the acidity or alkalinity due to other life therein, is especially worthy of note.

The chemist has analyzed the breakfast foods and published his results in bulletin No. 211, which is calling renewed attention among all classes of people to the importance of a wise selection of breakfast foods when both economy and health are considered. The station has no war against this material nor is its function to insist that the makers shall confine the remarks on the outside of the carton to either the truth or to the realm of possibility. The digestion work carried on with cattle during the past winter to determine the influence of the factor of succulence in the digestibility of a ration, awaits reconfirmation before publication. The results are interesting and give a value to that very element which has not been sufficiently considered.

The entomologist has devoted his attention very largely to the insects affecting tree fruits, resulting in the publication of special bulletin No. 24. Coming as this bulletin does, at a time when the enemies of our orchards seem to be in the ascendency, its appearance is most opportune and cannot but result in better methods in handling our orchards.

Farther comment on the reports of the heads of the several divisions hereto annexed is not needed.

C. D. SMITH,
Director.

Agricultural College, Mich.
June 30, 1904.

To the President:

The annual report of the Upper Peninsula Experiment Station for the crop season of 1903 is printed elsewhere in this volume and I need not here offer you an extended report of the work accomplished at that sub-station, farther than to say that the clearing has continued during the early months of 1904 and that at the thirtieth of June, 1904, the entire space between the house and barn and the railroad is cleared and improved, awaiting certain ditches before it will be in the very highest state of cultivation.

I may add by way of comment that the influence of the station upon rural life in the Upper Peninsula is becoming more and more marked. The press is standing by the work we are doing and the people are relying upon us for advice as to crops and care of live stock.

Yours respectfully,
C. D. SMITH,
Director.

REPORT OF THE HORTICULTURIST.

Prof. C. D. Smith, Director:

Sir—While a large amount of work has been done by the Horticultural Department of the Experiment Station at the College, even more attention has been paid to work in various parts of the State in cooperation with farmers and fruit growers, and at South Haven several new lines have been taken up in addition to the work that has been done in previous years.

At the College the orchard and garden crops have been cared for under the direction of Professor U. P. Hedrick and the note-taking was done during the summer and fall by Mr. M. L. Dean, Assistant Horticulturist, up to October 1, when he resigned to take charge of the interests of Michigan horticulture at the St. Louis Exposition.

Many of the apple trees which were planted in the station orchard from 1890 to 1895 bore a good crop of fruit last year. Carful notes were taken from them and many new varieties were photographed. Good results were also obtained from many of the new varieties of plums and pears, but owing to the injury from the May frost, comparatively little was secured from the cherries.

Although the early strawberries were severely injured by the frost on the night of April 30, the season was so favorable during the month of May, that a very good crop was secured and a large number of the kinds which fruited for the first time showed considerable value. In fact, so far as new varieties were concerned, it was one of the most promising collection of strawberries we have ever grown. Descriptions of all the new kinds and general notes upon the older varieties of strawberries were published in a bulletin. This also included descriptive notes upon new varieties of raspberries and blackberries. Large collections of tomatoes and potatoes were also grown and a bulletin giving the results was published in May.

In addition to the variety tests of fruits and vegetables, especial attention was paid to spraying experiments. Among others was a comparative test of liquid and dust sprays for preventing injury by insects and fungi. For this purpose a gasoline spraying outfit was used for the liquid applications and a dust sprayer made by the Kansas City Dust-Spray Mfg. Co., for applying the dust. The applications were made of the usual strength and in a general way the following were the results: The liquid applications which consisted of Bordeaux mixture and arsenic were applied four times during the season and were far more effective against apple scab than the dust application, even though a larger number of applications were made. Fairly good results were received against insects although less marked than where the liquid sprays were used. This agreed very closely with what was secured at South Haven Station in a similar experiment.

Although the cost of material for a single spraying is less than when liquid applications are used, the number of applications having to be increased 50 per cent in order to secure satisfactory results even against

leaf eating insects, it brings the cost of the dust applications nearly up to that of the liquid sprays. In favor of the dust sprays may be urged that they require less labor than the liquid applications, are better adapted for use upon rough and uneven ground and especially in sections where water cannot be readily obtained. They are, however, generally quite satisfactory against the canker-worm, codling moth and other leaf-eating insects, and the machinery in use today will make it possible to rely upon dust sprays against the potato beetle. While less effectual than liquid sprays against fungous diseases in the experiments made up to the present time, it is possible that improvements in the formulas or in the methods of compounding them may increase their value against the parasitic fungi.

During the year a considerable number of experiments were taken up in the vicinity of South Haven and Benton Harbor in cooperation with numerous fruit growers. The more important were concerned with the testing of various mixtures for the destruction of the San José scale. Up to the present time the most effectual preparation has been the sulphur, lime and salt, prepared after the California formula. During the last year it has been used by hundreds of fruit growers and where properly prepared and thoroughly applied, it has not only served to destroy the scale and other insects but it has proved very effectual against apple-scab, leaf-curl and other fungous diseases. In many instances trees that had through neglect become coated with rough bark and lichens were after spraying with the sulphur, lime and salt mixture left with a clean, healthy bark. A large number of fruit growers who were obliged to spray their trees for the destruction of the scale, were so well pleased with the results that they almost considered it a blessing that their trees had become infested.

The great drawback to the use of the California wash is that it requires boiling for an hour or more and when one is not equipped with the necessary apparatus it is a tedious job, especially if a large quantity is required. However, by the use of a steam boiler or a stock feed-cooker the work is greatly simplified and an outfit of this kind will always be found desirable if a considerable number of trees are to be sprayed. During the year, various methods of preparing this mixture without actually cooking it have been recommended and it was thought advisable to test them in order that their merits might be ascertained and in case any of them proved effectual, it was hoped that the saving of labor that would result might be of value to the hundreds of persons in Michigan who have a few infested trees. One of the methods tested made use of the heat produced by the slaking of the lime for boiling the mixture. Another introduced caustic soda without any attention to boiling. Another remedy which has been highly recommended by a leading agricultural paper, is a solution of caustic soda and, although little was expected from it, it was thoroughly tested upon several orchards. While it is not possible to give definite results, the indications at this time are that none of the preparations are as effectual as the thoroughly cooked sulphur, lime and salt, and that the benefits derived from the caustic soda solution are the least marked of all. The San José scale multiplies so rapidly that even though only a few per cent of the insects survive the treatment, the number upon a tree after one brood has developed may be greater than before the trees were sprayed, while after

two or three broods have developed, the incrustation may be many times thicker than in the beginning. It will, therefore, be seen that only the most effectual remedies should be used and a little extra care in preparing and applying them will be well repaid.

Observation during the past year in many parts of the State indicates that very few appreciate the importance of thoroughness in spraying. In many cases the mixture was applied with a brush to the trunk and larger branches, and the remaining portions of the trees were left untreated. This was generally in the villages and cities where the owners of the trees did not possess a spray pump. A large number of fruit growers, whose premises were visited, evidently thought they were very thorough in the work, but it was not uncommon to find an occasional tree that had been missed and in a large number of instances the trees were sprayed from one side only. Under these circumstances, it is not strange that occasional failures were reported.

Among the other experiments that are being carried on in a cooperative manner are several upon lines relating to the pruning of the trees, the thinning of the fruit, the use of various fruit packages, as well as experiments in cultivation and the use of various fertilizers and cover-crops.

In the vicinity of Douglas, Allegan county, an experiment was undertaken last July in co-operation with the Division of Vegetable Pathology of the U. S. Department of Agriculture, and with my own work as State inspector of nurseries and orchards, to test the effect of prompt eradication in restricting the disease known as "little-peach." During the past ten years, this disease has destroyed thousands of trees within five miles of Douglas and its ravages are rapidly extending. Professor M. B. Waite, a special agent of the department, has devoted several weeks each summer for a number of years in studying the disease but, as yet, has arrived at no conclusion regarding its nature, except that it appears to be highly contagious and fatal to all trees attacked by it. The disease appears to have no choice of soil, variety, or in the nature of the surroundings, and it develops in a tree so gradually that for some weeks its presence would only be detected by an expert. As previous experiments in spraying and the use of fertilizers have given no results, it was thought advisable to make a thorough test of promptly removing infected trees, upon the spread of the disease. A section containing some seven square miles, just south of the village of Douglas, which is somewhat detached from other peach orchards, was examined three times during July, August and September, 1903, and all trees found infected with this disease were marked, and the owners were ordered to remove and destroy them. This could be done under the orchard inspection law as Mr. Horace G. Welch, who had the matter in charge, under my direction, is a deputy inspector of nurseries and orchards. Although thousands of infected trees had previously been removed by the owners, some 3,000 were found to be infected and their removal was ordered. In nearly every case, the owners were convinced of the dangerous nature of the disease and were only too glad to cooperate by promptly removing all of the trees whose destruction was ordered. It is proposed to continue this experiment this year and again in 1905 and it is hoped that at the end of the third year, it will be possible to

reach some conclusion regarding the effect of eradicating all trees found to be infected.

During the year, Mr. T. A. Farrand has continued in charge of the South Haven Sub-station, and has attended to his duties in a thoroughly satisfactory manner. In addition to supervising the work and preparing his report, he devoted several weeks to nursery and orchard inspection and made numerous visits to the premises of fruit growers, in the vicinity of South Haven, who desired to consult him regarding the attack of troublesome insects or diseases or the care required by their orchards, He has also given considerable time to attending farmers' institutes and meetings of horticultural societies. As all persons interested in fruit growing are welcome at the station, a large number of visitors call there each year and the attention required by them takes no small amount of time during the summer months.

Respectfully submitted,

L. R. TAFT,

Horticulturist.

Agricultural College, Mich.

June 30, 1904.

REPORT OF CONSULTING VETERINARIAN.

Director C. D. Smith:

As Consulting Veterinarian for the experiment station I have the honor of presenting the following report:

As in former years much of my work in this connection has been the answering of letters with reference to diseases of live stock. During the past year the questions asked have not pertained to any particular disease, but rather to a large number of the non-contagious disorders. Few questions have been received with regard to the contagious diseases. The contagious swine disorders have probably caused the greatest losses during the past year.

The "Grand Traverse" or "Lake Shore" disease has caused quite extensive losses in certain sections. While the disease has been studied during the year nothing definite has as yet been determined as to its cause or causes, or as to its successful treatment except the moving of the diseased animals to a locality where the disease does not occur, in which case they recover with little or no treatmnet except good care and feed. Experiments are in progress for determining the value of certain drugs as curative agents when used in the infected districts, but we cannot as yet say as to the ultimate result of the experiments. We hope to continue the study the coming year in connection with others, and if possible find a prevention or cure for the disease.

Respectfully submitted,

GEO. A. WATERMAN,

Consulting Veterinarian.

Agricultural College, Mich.

June 28, 1904.

REPORT OF THE CHEMIST.

Prof. C. D. Smith:

Dear Sir—I beg leave to submit the following brief outline of the work of the Division of Chemistry for the year just past:

There is probably no branch of science that requires greater expenditure of energy to accomplish results than does chemistry. Indeed it is often the case that what requires a whole year's time in laborious and painstaking analytical work can be recorded in a few short paragraphs and tables. Yet it is only in this manner that reliable results can be obtained. No problems in chemistry are solved by the pen but all are reached solely through the medium of hard, steady, analytical work.

As noted in a previous report the outward signs of the work of this division are revealed in the two bulletins issued but that which appears in the few pages of these bulletins is little indication, to the popular mind, of the vast amount of analytical work required to establish the results obtained. The bulletin on Breakfast Foods is a step somewhat beyond the work done by the station in former years and there is abundant need for information along this line.

The fertilizer control work placed under the supervision of this division, is steadily increasing and demanding each year more and more time. The requirements of the work are likewise increasing and it has been our policy to make this work as thorough and of as great benefit to the agricultural interests of the State as is possible. I refer you to the Secretary's financial statement as to the income on account of this work.

A year ago an experiment in animal nutrition was planned and it has now been carried through two winters. The results will be given some time during the present summer or early fall. Little is definitely known concerning the processes in animal nutrition, and it is an exceedingly difficult line to study. It has been our hope and purpose to continue the study of these problems, as we have opportunity, as a contribution to greater knowledge concerning them. Several experiments in soils are now being pursued which bear considerably on problems in plant and animal nutrition and it is hoped that some light may be turned on these subjects.

A great deal of work comes to us from other departments—work in sugar beet culture, fertilizer experiments, plant breeding, etc., which means to us nothing but routine analytical work and which does not appear largely to the credit of this division. At the same time these experiments, as cited above, could not be carried to a successful conclusion without the cooperation of this division. It is in this manner that the division of chemistry is related to the other divisions of the experiment station.

The experiment station has repeatedly urged the necessity of a state control of the commercial feeding stuffs in a manner analogous to the fertilizer control work. We attended a meeting at the Round-up Institute and gave a short address on commercial feeding stuffs. At the

conclusion of the session resolutions were passed both by the State Dairymen's Association and the Farmers' Institute, calling on the Legislature to enact a law regulating the sale of these feeds. It is hoped that such a law will be enacted by the coming Legislature.

At the death of Dr. R. C. Kedzie, the meteorological records which had been kept by him privately for over forty years, were gathered together and this division has assumed the responsibility for their care. A great deal of work is required in this matter and some expense is involved, yet it is our purpose to maintain these records until the board makes some permanent provision for them. It has seemed to the writer that in view of the fact that our record here is the oldest in Michigan by a number of years, and so far as he is aware, is the oldest in the Northwest, it would be not injudicious to request the United States government to provide a separate building and maintain a government observer to keep the records and to report weather indications from this point.

During the past winter, at the request of the Dean of the Short Courses, we conducted a six weeks' course in the elements of agricultural chemistry and a six weeks' course in the elementary principles of animal nutrition for the students in live stock and general farming. These courses were highly successful and it is believed were appreciated by the student.

In November, 1903, the Board authorized us to attend the meeting of the Association of the Official Agricultural Chemists at Washington, D. C. It will be remembered that this station has always been active in the cooperative work of this association and it is our desire to continue this policy. These meetings are solely for the purpose of widening the scope and views of the various station chemists and for unifying the various methods of analysis. So much of the chemist's work is official in character that this association has become one of the most practical, scientific associations existing.

The work of this division became so great that early last fall we were authorized to employ an assistant. Miss Dorethea Moxness, a recent graduate of a technical school in Norway, was procured and she has demonstrated unusual ability in the work she has undertaken. It is with exceeding pleasure that I thus mention her capabilities and express my appreciation of her able and hearty cooperation in the chemical work of this division.

Very respectfully submitted,
FLOYD W. ROBISON,
Chemist.

Agricultural College, Mich.
June 30, 1904.

REPORT OF DEPARTMENT OF BACTERIOLOGY AND HYGIENE.

Agricultural College, Mich., July 1, 1904.

Director C. D. Smith, M. A. C.:

Dear Sir—In making our report for the year ending June 30th, I desire to state that work has been much retarded during the year because of the time given to installation in our new building. Time and energy have been required to adjust ourselves and to arrange satisfactorily for both research and class work.

Again, Mr. Barlow, who had been with us for one year and had become very efficient in soil and plant studies, was called to take a more responsible position elsewhere. By his departure, research in soil and plant bacteriology has been brought to a standstill, consequently, the experimental work which was in progress at the time of his leaving, has yielded no results sufficiently matured to be given to the public. Mr. Barlow showed a peculiar knowledge of the field in which he was experimenting, and we anticipated excellent results from him. We trust, however, that what he has not given to us, he will be able to furnish to the institution in which he now labors.

Mr. W. R. Wright, who has taken Mr. Barlow's position, has given his entire attention to dairy bacteriological studies, and has assisted me in many of the experiments. Mr. Wright, in connection with myself, will soon be able to issue a bulletin, setting forth some results obtained from the study of the germs of milk fermentation and the use of starters in controlling them. He also is interested in another bulletin, being associated with Mr. Michels and myself, in which are discussed the methods of handling and caring for milk. In this connection, I wish also to refer to the fact that Mr. Howard, who is at present a student in the College, has done some excellent work in dairy bacteriology, and this work will soon be in bulletin form.

I regret very much to inform you that Mr. S. F. Edwards, who has been with us for the past four years, is about to leave for the purpose of taking up advanced studies in bacteriology. Although Mr. Edwards has been largely connected with the class work of this department, he nevertheless has done very commendable research work in soil bacteriology, so far as time permitted him, and has also assisted in carrying out much of the routine work of the laboratory. By this, I mean that many specimens which have been sent here have been taken care of through his instrumentality. Such work is by no means light, and Mr. Edwards has shown a willingness and a dexterity in executing this work that deserves mention.

I have also to inform you that Mr. Edwards has ready a bulletin which has been written for the purpose of setting forth some of the problems involved in soil bacteriology. It is purely a popular bulletin, and Mr. Edwards has written it in a very happy manner. While I think that the Experiment Station is under deep obligation to Mr. Edwards, this department, moreover, feels a greater and deeper obligation for his assistance in the past in conducting its affairs, and in aiding in its progress.

So far as my own work for the past year is concerned, may I be permitted to say that it has been confined almost exclusively to the study of the associative action of bacteria in the souring of milk; in other words, what influence some saprophytic germs have upon the growth and development of lactic acid bacteria. I have issued two bulletins upon my work thus far, and the work, practically completed, and done in association with Mr. Wright and Mr. Howard, will present further results along this same line. We feel that this field is only fairly opened, and hope that the future will reveal much more than we have already accomplished.

Besides the above work, we have been called upon to do some testing and experimenting in connection with hog cholera—like epidemics and the Grand Traverse cattle disease. Other work is in progress, but it is only in an incipient stage, consequently, it is not worthy of mention.

I wish to acknowledge personally my indebtedness to those who have assisted in the work of the department in one way or another, and especially, to the efficient services of Messrs. Edwards, Wright, Howard and Parker.

Very respectfully submitted,

CHARLES E. MARSHALL.

Agricultural College, Mich.
June 30, 1904.

REPORT OF THE DEPARTMENT OF AGRICULTURE.

Director C. D. Smith:

The following is a brief report of the work done in live stock experimentation during the year ending June 30, 1904:

BEEF CATTLE.

During this year the fourth of a series of experiments in beef cattle feeding was completed. The primary object of these experiments has been to determine the relative amounts of beef which could be produced from the product of equal areas of corn fed in three different forms, viz.: as silage, shock corn, and corn and cob meal and stover. For the purpose of this experiment twenty-four Shorthorn grade steers were purchased in Chicago on October 14, 1903. Three lots of six each were fed on the corn products, the fourth lot was fed raw beet pulp during the first feeding period and dried beet pulp during the second. This experiment was completed on March 9, 1904, after a twelve-weeks' test. Records have been kept not only of the performance of the various lots, but also of each individual as well, so that the record of each can be traced throughout every period from start to finish. In part this work duplicated that of the previous year.

The following rations were used:

(1) Corn, 4 pounds; bran, 2 pounds; linseed meal, 1 pound.

(2) Corn, 4 pounds; bran, 2 pounds; linseed meal, 1 pound; dried beet pulp, 7 pounds.

(3) Dried beet pulp, 4 pounds; bran, 2 pounds; linseed meal, 1 pound.
(4) Dried molasses-beet-pulp, 3 pounds; linseed meal, 1 pound.
(5) Dried beet pulp, 3 pounds; linseed meal, 1 pound.

So far as we could determine absolutely no undesirable conditions arose during this feeding trial to in any way interfere with the accuracy of the results. Further work along these lines would seem to be justifiable.

On June 1, 1904, eighteen yearling high-grade wethers were purchased for feeding purposes. These consist of six coarse wools (Lincolns), six medium wools (Shropshires), and six fine wools (Rambouillets). Each division of six has been divided into two lots of three each, one receiving a ration with a narrow nutritive ratio, the other being wide. The plan is to compare the various types as regards economical mutton production and also to study the effect of wide vs. narrow rations on economical production and quality of meat.

DAIRY CATTLE.

The lines of work mentioned in a previous report were continued during the year but results will not be available until the end of the present period of lactation. The first of a series of tests to determine the relative feeding values of dried beet pulp and dried molasses-beet-pulp for the dairy cow has been completed. This test should be repeated a number of times before accurate conclusions can be drawn.

SHEEP.

During the preceding year two lots of wethers and two lots of lambs were used in feeding tests to determine the value of dried beet pulp when added to a grain ration for the fattening wether and lamb. Since that time dried molasses-beet-pulp has been put on the market in large quantities. As a result five lots of lambs of eighteen each were fed during the year to determine: (1) The relative feeding values of dried beet pulp and corn; (2) the feeding value of dried beet pulp used in conjunction with grain rations and (3) the relative feeding values of dried beet pulp and dried molasses-beet-pulp.

SWINE.

Last year it was not possible to accomplish much in experimental work with swine owing to the fact that the equipment, both building and fencing, was incomplete. A series of investigations are now in progress with forage crops duplicating those which were grown and used last year.

ANGORA GOATS.

The purchase of Angora goats for feeding purposes was mentioned in our last report. The proposed feeding trials were interrupted by an outbreak of disease soon after the goats arrived from the west. The disease did not yield to treatment and has been identified as Lakosis a goat disease which has caused large losses in the west. During the past season the survivors were placed on cut-over timber land east of the College farm, where the second growth was very thick and several feet high.

The goats succeeded in clearing a portion of this land perfectly and thrived well on the rations thereby provided. The remaining goats are now being used by Mr. S. M. McKee of Portland, Mich., in a cooperative experiment to determine their ability to destroy thistles and weeds.

Yours respectfully,

R. S. SHAW.

Agricultural College, Mich.
June 30, 1904.

REPORT OF THE BOTANIST.

To the Director of the Agricultural College Experiment Station:

I herewith submit a brief outline of the work done by the Botanist of the Station during the year ending June 30, 1904:

During August, 1903, nearly one week was spent in the vicinity of West Olive in Ottawa county, investigating the flora of that region with reference to some possible connection between the plants growing there and the prevalence of the so-called "Lake Shore Cattle Disease." My report, which has already been handed you, shows that in all probability this peculiar ailment is in no way due to the eating of poisonous plants by the cattle affected; also that the trouble is confined to the water-washed sands adjoining the shore of the lake.

During the summer and autumn of last year comparative studies were made of twenty-three species of vetches which were growing on the experimental plots. Detailed descriptions were made of each so-called species and an analytical key was constructed to aid in their classification. Photographs were also made to illustrate the typical forms and the characters used in constructing the key. A number of the species were found to be practically synonymous judging from the material at hand; but as there is some possibility that the seed from which the plants were grown was not true to name, it seems hardly advisable to publish the descriptions and key without first proving the authenticity of the specimens.

A number of photographs of edible and poisonous fleshy fungi were taken during the past season with the intention of using them for illustrating another bulletin on Michigan mushrooms. A large number of fleshy fungi have been identified by the botanist for correspondents in various parts of the State; in fact this subject is steadily gaining interest on the part of many persons.

Those fungi which are the cause of specific diseases of plants have occupied much of the botanist's time and attention. In this connection Special Bulletin No. 25 "Fungous Diseases of Fruit" has required much labor in preparation. The cuts, forty-two in number, are with two exceptions, original and show the most recent knowledge of our structure of the disease organisms described. It is proposed to continue this work during the coming season, the diseases of vegetable and garden crops being next in order.

During the winter and spring terms classes of special students were instructed by lectures and experiments in elementary botany, seed testing and in the study of the fungous diseases of plants. The difficulties involved in trying to pack a four years' course of a scientific character into six weeks and working with overflowing classes of untrained students can hardly be properly appreciated by the person who has not tried it. Nevertheless, there is no doubt some compensating good which the student derives even under such adverse circumstances and which he may carry away in the form of a greater interest and enthusiasm in his work of tending and rearing plants.

The usual work of identifying weeds and weed seeds and the testing of farm seed for inpurities and vitality has been furnished by farmers and others. In this connection a brief bulletin has been written and illustrated by the botanist on the subject of seed testing for farmers. This is a subject about which every planter of farm seeds should know something and it is gratifying to be able to aid in any way the dissemination of such information.

Two trips were made recently to investigate diseased conditions in plants. The first was to determine the cause of death of young apple trees in the orchard of B. F. Hall at Belding. Out of a block of about 2,400 Baldwin trees, set two years ago, nearly one-third were found to be dead or in a dying condition. The trouble was determined as due to the severe winter which killed the roots of the trees, especially on the higher ground, where the snow blew off. Reports of a similar trouble, especially in the case of the Baldwin apple, have not been uncommon, this spring and point to the common observation among horticulturists of the tenderness of this variety.

At Grand Rapids the hot house grown cucumbers of F. M. Strong were recently found to be affected somewhat by a leaf spot disease due to the Anthracnose of Cucurbits. A wilting of some of the plants in the same house and due to physiological causes was also found. This wilting occurs in the case of plants which have been started early and forced rapidly with improper light and ventilation, thus causing a tender growth of foliage incapable of resisting the hot sun later in the spring. A similar condition was found in the houses of Mr. John Nellist in the same city.

Respectfully submitted,
B. O. LONGYEAR,
Botanist.

Agricultural College, Mich.
June 30, 1904.

REPORT OF THE ENTOMOLOGIST.

Annual report of the Department of Entomology of the Experiment Station for the year ending June 30, 1904.

Prof. C. D. Smith, Director:

Following is a brief report of the work done by the Department of Entomology for the year ending June 30, 1904.

One bulletin has been issued during the year by this office, Special Bulletin No. 24, dealing with insects affecting fruits in Michigan.

The experiment bearing on the control of mosquitoes commenced in 1902-3, has been continued this spring, thus far with very gratifying results in spite of the extremely wet weather during the early breeding season.

Work with the codling moth instituted last year is being continued in order that spraying tests may be made before publishing results obtained during the first year's work, and in order also to check up the dates obtained at that time. The work on fumigation of green houses and forcing houses for insect pests is being systematically carried forward, as occasion permits, with very good results, notably those obtained from the vaporization of tobacco extracts. A small experimental garden is now available for testing remedies against garden insects.

Several new pests have appeared during the season, a bill bug working in corn, a borer in potato stalks, a new enemy of tomatoes, and a new pest working in small peach stocks.

An experiment in cooperation with the farm department, to test the various methods of curing mange in hogs, has been started, about twenty hogs being under treatment at present. Studies in scale insects are being made a little at a time as opportunity offers. This work has to be done from time to time, when other work does not claim too much attention.

The equipment of the department is constantly being added to. Books and apparatus are added as need occurs and funds allow. The bibliography of writings on Michigan insects is being compiled on cards. This should be of great service when brought up to date. The writer wishes to acknowledge the careful and painstaking assistance rendered by Mr. H. F. Tuttle, Charles H. Mosier and V. R. Gardner, who have done much to make the department efficient.

Respectfully submitted,

R. H. PETTIT,

Entomologist.

Agricultural College, Mich.

June 30, 1904.

METEOROLOGICAL TABLES.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.			Relative humidity or per cent of saturation.			Barometer reduced to freezing point.			Registering thermometer.	
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Maximum.	Minimum.
1......	14	38	26	100	100	100	29.153	29.128	29.088	39	13
2......	24	33	32	100	100	100	29.091	28.825	28.703	36	23
3......	33	34	26	100	100	100	28.612	28.639	28.711	35	24
4......	25	27	24	100	100	100	28.768	28.708	28.888	29	19
5......	22	22	22	100	100	100	28.778	28.792	28.791	32	10
6......	21	25	19	100	100	100	28.748	28.527	28.357	32	18
7......	32	35	19	100	100	100	28.051	28.134	28.475	35	9
8......	11	14	13	100	100	100	28.642	28.673	28.647	18	0
9......	1	16	11	100	100	100	28.680	28.741	28.818	16	0
10......	10	19	10	100	100	100	29.034	28.988	28.718	19	9
11......	11	18	1	......	100	100	28.567	28.312	28.555	18	−7
12......	−6	15	3	100	100	100	28.902	28.992	29.068	19	−6
13......	4	18	16	100	100	100	29.143	29.112	29.138	18	4
14......	18	31	24	100	100	100	29.163	29.048	29.018	31	17
15......	31	33	29	100	100	100	28.848	28.865	28.895	34	18
16......	27	38	33	100	100	100	28.885	28.862	28.800	40	26
17......	29	30	15	100	100	100	28.738	28.778	28.948	32	5
18......	13	16	10	100	100	100	29.111	29.219	29.297	16	−4
19......	5	19	6	100	100	100	29.369	29.214	29.177	19.5	−1
20......	10	35	26	100	90	100	29.048	29.012	29.005	35	10
21......	25	26	22	100	100	100	28.905	28.948	28.983	26	16
22......	19	30	18	100	100	100	28.891	28.872	28.885	30	15
23......	15	22	16	100	100	100	29.229	29.204	29.161	22	7
24......	13	21.5	10	100	100	100	29.125	28.985	29.040	22	3
25......	7	23	20	100	100	100	29.045	29.047	29.098	29	6
26......	29	40	40	100	91	100	29.040	29.032	29.020	40	27
27......	35	38	37	100	100	100	29.012	28.982	28.980	38	35
28......	38	45	40	100	100	100	28.942	29.037	28.772	45	34
29......	44	48	34	100	100	100	28.457	28.462	28.464	48	17
30......	17	20	14	100	100	100	28.738	28.777	28.992	20	11
31......	16	20	24	100	100	100	29.033	28.774	28.755	36	15
Sums....	593	850	640	3000	3081	3100	895.748	894.689	895.247	899	384
Means...	.....	.....	.....	100	99	100	....	....	....	......	......
Average.	.....	.....	.....		100		....	....	....	......	......

JANUARY, 1903, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.					
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Beginning rain or snow.	Ending rain or snow.	Inches of rain or melted snow.	Depth of snow inches.
0		0		40		s w		s w		s					
100		100		100		e		n e		n		*	night	.54	5.4
100		100		100		n w		n w		n w		†			.25
100		100		90		w		s w		w		†	9 a. m.		.5
100		50		40		n		n		n w		Snow			trace
100		100		100		w		s w		s w		4:30 p.m.	Snow		
100		100		0		s w		n w		n w			5 p. m.		.45
90		90		50		n w		n w		n w		Snow			trace
50		100		80		s		s w		s w					
80		60		70		w		s w		s w		6 a. m.	Snow		
100		100		100		s w		w		s w			9 p. m.		5.0
90		100		100		s w		s w		s w					
100		100		100		s w		s w		s w					
100		100		100		s		s w		w					
100		100		100		w		w		w					
90		80		0		w		s w		s w					
60		40		10		s w		w		w					
90		90		0		n w		n w		w					
10		0		0		s		s		s e					
0		0		0		s		s		s					
10		20		20		n		n w		n w					
10		30		90		n w		n		n e					
80		50		20		n e		n e		e		†			5.0
100		50		90		e		n		n		†			
0		20		100		s w		s e		s e					trace
100		80		100		s		s		s					
100		100		100		s		s		s		Rain			trace
100		100		100		s e		s		s					
100		100		100		s		s w		s w		Snow			trace
90		50		0		s w		w		n w					
0		50		100		w		s w		s					
2240		2160		2000										.54	
72		70		65											
		69													

* Rain 1:30 p. m. † Snow in night.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.			Relative humidity or per cent of saturation.			Barometer reduced to freezing point.			Registering thermometer.	
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Maximum.	Minimum.
1......	36	39	35	100	100	100	28.738	28.732	28.720	39	33
2......	36	38	38	100	100	100	28.702	28.787	28.962	38	24
3......	30	38	30	100	100	100	29.043	28.887	28.770	41	23
4......	29	31	19	100	100	100	28.207	28.777	28.795	34	9
5......	11	30	18	100	100	100	29.018	29.065	29.203	30	12
6......	14	30	14	100	100	100	29.242	29.243	29.250	31	11
7......	12	30	26	100	100	100	29.263	29.092	28.557	30	11
8......	18	28	18	100	100	100	28.604	28.725	28.872	29	9
9......	22	34	21	100	100	100	29.103	29.138	29.040	34	20
10......	30	36	23	100	100	100	29.308	29.551	29.180	38	22
11......	33	36	29	100	100	100	28.542	28.434	28.562	36	27
12......	30	38	26	100	100	100	28.808	28.855	29.067	39	22
13......	25	37	18	100	100	100	29.141	29.245	29.263	39	10
14......	21	30	20	100	100	100	29.298	29.303	29.265	31	19
15......	21	26	17	100	100	100	29.122	29.075	28.992	26	—2
16......	—1	10	—7	100	100	100	28.948	28.855	28.778	10	—17
17......	—15	11	1	100	100	100	28.801	28.798	28.800	11	—15
18......	0	4	—11	100	100	100	28.808	29.005	29.227	4	—11
19......	1	16	10	100	100	100	29.430	29.369	29.371	16	10
20......	8	25	10	100	100	100	29.336	29.296	29.206	25	20
21......	20	20	14	100	100	100	29.008	29.158	29.269	26	11
22......	18	26	25	100	100	100	29.395	29.381	29.371	28	2
23......	30	34	12	100	100	100	29.133	29.248	29.306	36	8
24......	8	33	20	100	100	100	29.374	29.351	29.387	34	4
25......	10	36	21	100	100	100	29.428	29.368	29.366	37	6
26......	17	41	32	100	100	100	29.319	29.296	29.282	47	8
27......	37	45	41	100	100	100	28.912	28.855	28.520	46	25
28......	37	38	20	100	100	100	28.333	28.406	28.915	38	20
Sums....	538	840	540	2800	2800	2800	812.364	813.295	813.296	874	321
Means...	.....	.....	.....	100	100	100	....	....	....	27	27
Average.	.....	.....	.....	100			....	....	....	30.89	10.67

FEBRUARY, 1903, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.					
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force	Beginning rain or snow.	Ending rain or snow.	Inches of rain or melted snow.	Depth of snow inches.
100	....	100	....	100	....	s	..	s	..	s e	..	....	....	....	......
100	....	100	....	80	....	s e	..	s	..	s w	..	....	....	....	......
100	....	100	....	100	....	s w	..	s	..	s e	..	11 a.m.	....	....	......
100	....	100	....	100	....	s	..	n	..	s w	..	....	night	....	2.0
20	....	0	....	0	....	s	..	s w	..	s w	..	....	....	....	......
0	....	0	....	0	....	s	..	n	..	n w	..	....	....	....	......
0	....	10	....	60	....	n e	..	n	..	n w	..	10 p. m.	....	....	......
100	....	50	....	80	....	n	..	w	..	s w	..	....	9 a. m.	....	6.0
100	....	100	....	80	....	s	..	s w	..	s	..	....	....	....	......
0	....	30	....	90	....	s w	..	s w	..	n w	..	*†	....	....	......
100	....	80	....	100	....	n e	..	s w	..	w	..	....	noon	.3	......
90	....	50	....	60	....	w	..	w	..	w	..	....	....	....	......
100	....	90	....	100	....	n	..	n w	..	w	..	....	....	....	......
60	....	70	....	90	....	w	..	n w	..	n	..	*	....	....	......
100	....	100	....	100	....	n	..	n	..	n	..	....	night	....	3
0	....	0	....	10	....	n	..	n w	..	w	..	....	....	....	......
0	....	90	....	60	....	s	..	s w	..	s w	..	Snow	....	....	$\frac{3}{4}$
80	....	0	....	0	....	w	..	n w	..	n	..		....	....	......
30	....	40	....	20	....	n w	..	n w	..	w	..	....	....	....	......
0	....	60	....	100	....	s w	..	s	..	w	..	*	....	....	......
100	....	100	....	50	....	w	..	w	..	w	..	....	a. m.	....	1
80	....	0	....	0	....	w	..	s	..	s	..	....	....	....	......
100	....	0	....	0	....	s w	..	w	..	n w	..	....	....	....	......
0	....	0	....	0	....	n w	..	w	..	w	..	....	....	....	......
0	....	0	....	10	....	s w	..	s w	..	s w	..	....	....	....	......
0	....	0	....	0	....	s w	..	s	..	s	..	†	....	trace	......
100	....	100	....	100	....	s	..	s	..	s	..	....	....	....	......
100	....	100	....	100	....	s	..	s w	..	n	..	....	night	trace	......
1660	....	1480	....	1570	....	...	..	...	..	...	..	....	....	0.3	12.75
59	....	53	....	56	....	...	..	...	..	...	..	....	....	....	......
		56				...	..	...	..	...	..	....	....	....	......

* Snow in night. † Rain in night.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.			Relative humidity or per cent of saturation.			Barometer reduced to freezing point.			Registering thermometer.	
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Maximum.	Minimum.
1......	18	25	20	100	100	100	29.121	29.112	29.196	26	16
2......	25	35	32	100	100	100	29.229	29.245	29.304	39	18
3......	27	40	34	100	100	100	29.377	29.361	29.326	41	24
4......	31	.....	34	100	......	100	29.309	29.245	29.103	......	24
5......	33	.....	35	100	......	100	29.042	29.085	29.206	......	32
6......	33	38	37	100	100	100	29.258	29.201	29.065	38	36
7......	44	51	42	100	100	100	28.870	28.912	29.072	51	40
8......	35	45	32	100	100	100	29.146	29.185	29.263	46	25
9......	32	49	39	100	100	100	29.377	29.333	29.295	50	35
10......	37	49	38	100	100	100	29.216	29.215	29.293	49	36
11......	39	47	41	100	100	100	29.383	29.410	29.340	48	38
12......	40	50	40	100	100	100	29.321	29.303	29.285	50	36
13......	38	52	45	100	100	100	29.201	29.170	29.180	53	37
14......	35	48	36	100	100	100	29.211	29.203	29.255	48	34
15......	31	47	39	100	100	100	29.308	29.260	29.195	50	30
16......	38	50	45	100	100	100	29.135	29.037	29.022	52	38
17......	50	55	41	100	100	100	29.010	29.057	29.067	56	40
18......	52	65	62	100	100	100	29.102	29.082	29.070	65	42
19......	60	74	62	100	100	94	29.062	29.004	28.907	75	54
20......	60	59	40	88	100	......	28.795	28.812	28.883	74	48
21......	30	41	39	......	91	100	28.993	28.969	29.047	50	30
22......	42	50	38	83	79	100	29.072	29.009	28.935	50	35
23......	36	45	36	100	100	100	28.805	28.782	28.750	49	35
24......	32	.....	31	89	......	100	28.791	28.792	29.015	40	28
25......	31	47	36	100	100	100	29.098	29.062	29.095	48	29
26......	32	48	39	100	100	100	29.153	28.997	29.052	50	25
27......	39	45	34	100	100	100	29.068	29.075	29.105	48	28
28......	30	40	29	100	100	100	29.236	29.280	29.381	41	20
29......	30	40	32	100	100	100	29.463	29.401	29.256	43	29
30......	31	55	32	100	90	100	29.045	28.821	28.822	55	21
31......	36	62	31	71	67	100	28.790	28.821	28.895	62	28
Sums....	1031	1352	1071	2931	2727	2994	902.987	902.271	902.680	1447	991
Means...	.....	.....	.....	98	97	100	....	....	....	31.9	49.9
Average.	.....	.....	.....		98		....	....	....	......	......

MARCH, 1903, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.					
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Beginning rain or snow.	Ending rain or snow.	Inches of rain or melted snow.	Depth of snow inches.
100	....	10	....	0	....	w	..	s w	..	s	..	....	....	....	......
0	....	0	....	0	....	s	..	s	..	s	..	....	....	....	......
0	....	60	....	100	....	s	..	s	..	s	..	Rain a.m	....	....	......
100	....	100	....	100	....	s	..	s e	..	e	..	....	night	.50	......
100	....	100	....	90	....	e	..	n e	..	e	..	....	....	....	......
90	....	100	....	80	....	s e	..	s e	..	e	..	Rain	....	.10	......
100	....	100	....	50	....	e	..	s	..	s	..	....	....	....	......
100	....	0	....	0	....	n e	..	n	..	e	..	....	....	....	......
100	....	0	....	20	....	e	..	e	..	e	..	Rain	....	.10	......
100	....	100	....	100	....	n e	..	n	..	n	..	....	....	....	......
100	....	100	....	100	....	n	..	n	..	n	..	....	....	....	......
100	....	0	....	20	....	s w	..	s w	..	s w	..	....	....	....	......
90	....	0	....	60	....	s w	..	s	..	s	..	....	....	....	......
50	....	100	....	100	....	n	..	n	..	n	..	....	....	....	......
100	....	100	....	100	....	n	..	n e	..	n	..	....	....	....	......
100	....	80	....	100	....	s	..	s	..	s e	..	Rain	night	.15	......
100	....	20	....	100	....	s e	..	n e	..	n	..	....	....	....	......
50	....	50	....	0	....	s w	..	s	..	s	..	....	....	....	......
50	....	30	....	0	....	s e	..	s w	..	s w	..	Shower	....	trace	......
60	....	50	....	90	....	s	..	s w	..	s w	..	Shower	....	trace	......
100	....	60	....	0	....	s w	..	s w	..	s w	..	....	....	....	......
0	....	40	....	50	....	s	..	s w	..	s e	..	....	....	....	......
100	....	50	....	100	....	e	..	s	..	s w	..	Shower	....	trace	trace
10	....	100	....	100	....	s e	..	s w	..	s w	..	....	....	....	......
100	....	50	....	40	....	w	..	s w	..	s w	..	....	....	....	......
0	....	20	....	50	....	s w	..	s	..	n	..	....	....	....	......
100	....	100	....	100	....	n	..	n	..	n	..	*	Snow	....	......
0	....	10	....	0	....	s e	..	n	..	n e	..	....	night	.40	......
0	....	80	....	100	....	n e	..	e	..	e	..	....	....	....	......
100	....	10	....	0	....	s e	..	e	..	s e	..	....	....	....	......
10	....	0	....	10	....	s e	..	n w	..	w	..	....	....	....	......
2110	....	1620	....	1760	....	...	..	...	..	...	..	....	....	1.25	......
68	....	52	....	57	....	...	..	...	..	...	..	....	....	....	......
		59				...	..	...	..	...	..	....	....	....	......

* Rain in night.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.			Relative humidity or per cent of saturation.			Barometer reduced to freezing point.			Register-ing ther-mometer.	
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Maximum.	Minimum.
1......	34	47	47	90	85	85	28.951	28.827	28.730	47	26
2......	51	68	60	100	79	100	28.564	28.337	28.394	68	46
3......	31	30	24	......	89	100	28.594	28.594	28.693	32	24
4......	21	33	22	86	79	100	29.103	29.149	29.203	34	13
5......	29	45	38	100	100	100	29.269	29.194	29.072	45	20
6......	38	58	53	100	82	86	28.945	28.717	28.687	59	33
7......	45	58	49	84	76	93	28.725	28.734	28.788	58	39
8......	42	58	.....	91	76	......	28.792	....	....	60	37
9......	.....	59	47	......	59	85	....	....	....	59	30
10......	38	54	48	91	87	85	29.153	29.080	28.905	54	40
11......	44	49	.....	84	100	......	28.860	28.805	28.805	......	41
12......	.....	.....	.....	......	......	......	28.748	28.667	28.656	......	......
13......	44	41	41	100	100	100	28.604	28.544	28.477	44	......
14......	42	44	42	100	92	91	28.432	28.512	28.602	44	......
15......	42	43	43	91	100	92	28.700	28.752	28.825	43	......
16......	40	52	38	82	73	81	28.918	28.959	29.030	52	......
17......	38	56	40	91	69	100	29.118	29.029	28.989	56	......
18......	44	61	41	76	66	100	28.888	28.842	28.845	61	......
19......	54	58	46	74	76	77	28.790	28.775	28.769	58	......
20......	41	58	40	74	64	82	28.892	28.867	28.925	58	......
21......	34	47	37	79	70	90	28.953	28.920	28.965	47	......
22......	33	41	37	100	82	90	28.973	28.990	29.013	44	......
23......	38	57	40	54	81	91	29.063	29.004	29.036	57	21
24......	47	41	41	85	100	91	28.961	28.875	28.918	49	36
25......	41	53	36	91	86	90	29.056	29.071	29.085	54	35
26......	43	59	38	83	82	81	29.133	29.061	29.184	60	27
27......	48	68	54	85	79	93	29.217	29.154	29.161	68	31
28......	62	75	61	77	86	94	29.141	29.099	29.087	75	31
29......	67	79	66	84	82	89	29.083	28.942	28.780	79	38
30......	65	.....	31	89	......	100	28.715	28.846	28.898	65	49
Sums....	1045	1326	1082	2341	2300	2466	809.549	808.346	808.517	1530	617
Means...	.....	.....	.....	87	82	91	....	....	....	54.6	32.4
Average.	.....	.....	.....		87		....	....	....	......	......

APRIL, 1903, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds						Winds.						Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.					
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Beginning rain or snow.	Ending rain or snow.	Inches of rain or melted snow.	Depth of snow inches.
80		90		100		s e		s e		s e		Shower		trace	
100		100		60		s		s w		w		Shower		trace	
100		100		80		n		n		n		*5 a. m.	*9 p. m.		5
0		50		0		n w		n w		n w					
0		10		30		s		s		s e					
90		100		60		s e		s		s					
0		10		40		s		s w		w					
30		10				s w		s w							
		0		0				n w		w					
75	Cu. St.	90	St.	100	Nim.	e		s e		e		Rain	10 p. m		
100	N. St.	100		100		e		e		e		Rain	8 a. m.	trace	
100	Nim.	100	Nim.	100	Nim.	e		e		e		Storm			
100	Nim.	100	Nim.	100	Nim.	e		n e		n		10 a. m	St. Ra.		
100	Nim.	100	Nim.	100		n e		e		e		Sl. Ra.			
100	Nim.	100	Nim.	50		n e		n		n w					
50	St. Cu.	0		0		n		n		n w					
0		0		0		n		n		w					
15	St.	15	Cu.	0		s w		s w		w					
25	Cu. St.	100	Cu.Nim	100	Cu. St.	e		s w		e				trace	
40	Cu.	0		40	Cu. St.	n e		n e		e					
0		100	Cu.	100	Nim.	n		n		n		9 p. m.		trace...	
100	Nim.	100	Cu.	80	Cu. St.	n		n e		n e		Snow		trace	
0		10		0		n		e							
100	St.	100	Nim.	100	Nim.	s		s e		e		9 a. m.	8:30 p.m.	.33	
90	Cu. St.	5	Cir. Cu.	0		n e		n e							
		5	St.	10		e		w		w					
0		0		0		n e		n e		n e					
80		5		50		se		s		s w					
0		0		40	Nim.									trace	
100	Nim.	100	Nim.	100	Nim.										
1575		1600		1540											5.00
56		53		53											
		54													

* Snow.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.			Relative humidity or per cent of saturation.			Barometer reduced to freezing point.			Registering thermometer.	
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Maximum.	Minimum.
1......	38	50	39	81	65	91	29.334	29.278	29.191	50	23
2......	44	60	40	76	100	100	29.139	28.946	28.852	60	31
3......	41	60	45	100	100	100	28.828	28.830	28.852	60	41
4......	44	62	52	76	88	86	29.191	29.102	29.145	62	27
5......	51	68	54	86	84	100	29.141	29.097	29.125	69	40
6......	58	69	56	88	90	100	29.112	29.089	29.135	69	42
7......	54	68	46	80	84	69	29.215	29.211	29.211	68	38
8......	49	68	48	71	84	85	29.198	29.051	29.083	68	40
9......	55	78	50	100	82	100	29.048	29.047	29.042	78	38
10......	62	78	54	88	86	100	29.045	29.010	29.040	80	48
11......	60	78	64	77	86	83	29.075	29.047	29.082	80	49
12......	64	80	64	78	82	83	29.130	29.125	29.130	82	52
13......	66	80	62	74	87	94	29.146	29.100	29.080	82	51
14......	50	70	54	100	75	93	29.060	29.057	29.062	70	50
15......	51	76	54	93	73	87	29.063	29.060	29.090	76	42
16......	56	80	55	75	82	93	29.123	29.036	29.102	80	42
17......	59	84	60	65	75	77	29.100	29.027	29.052	87	47
18......	70	80	61	75	78	88	29.075	29.042	28.995	87	50
19......	69	82	60	90	87	100	28.927	28.942	28.982	80	50
20......	65	81	61	84	74	94	29.032	29.010	28.992	82	55
21......	68	82	64	95	79	100	28.967	28.950	28.982	82	54
22......	57	68	58	94	100	88	28.990	29.007	29.052	82	57
23......	58	70	59	88	90	94	29.075	28.982	29.002	68	55
24......	63	72	58	89	90	94	29.015	29.060	29.082	70	50
25......	57	76	60	87	86	100	29.110	29.047	29.005	72	52
26......	68	71	70	90	95	90	28.942	28.857	28.795	76	57
27......	71	76	60	90	91	100	28.762	28.597	28.842	83	56
28......	60	72	58	94	90	91	28.900	29.052	29.095	77	66
29......	52	67	52	86	89	93	29.128	29.141	29.182	73	54
30......	48	59	50	93	94	86	29.194	29.178	29.186	68	48
31......	56	63	.....	87	72	......	29.196	29.148	29.175	56	42
Sums....	1708	2165	1668	2650	2648	2759	901.261	900.126	900.641	2277	1442
Means...	.....	.....	.....	85	85	92	....	....	....	73.45	46.55
Average.	.....	.....	.....		87		....	....	....	......	......

MAY, 1903, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.					
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind	Direction.	Force.	Direction.	Force.	Direction	Force.	Beginning rain or snow.	Ending rain or snow.	Inches of rain or melted snow.	Depth of snow inches.
0	....	0	....	0	....	s w	..	s w	..	s w	..	....	....	....	......
5	....	0	....	0	....	s w	..	s w	..	...	..	....	....	....	......
100	Nim.	100	Nim.	90	....	s w	..	s w	..	s w	..	*	....	.13	......
0	....	0	....	0	....	s w	..	w	..	s w	..	....	....	....	......
0	....	0	....	40	....	s w	..	w	..	s w	..	....	....	....	......
90	....	30	....	80	....	w	..	s w	..	w	..	....	....	....	......
10	....	0	....	0	....	w	..	n w	..	w	..	....	....	....	......
0	....	0	....	0	....	s	..	s	..	s	..	....	....	....	......
0	....	0	....	0	....	s	..	s e	..	s	..	....	....	....	......
0	....	0	....	0	....	s	..	s	..	s	..	....	....	....	......
10	....	40	....	30	....	s	..	s	..	s	..	....	....	....	......
40	....	0	....	10	....	s	..	s	..	s	..	....	....	....	......
0	....	50	....	80	....	s	..	s	..	s	..	....	....	....	......
100	....	30	....	0	....	s	..	s	..	s	..	....	....	....	......
0	....	0	....	20	....	s	..	s w	..	n	..	....	....	....	......
0	....	0	....	0	....	w	..	s e	..	e	..	....	....	....	......
0	....	90	....	0	....	e	..	s w	..	s	..	†	....	.08	......
20	....	10	....	50	....	...	..	s w	..	s w	..	....	....	....	......
80	....	100	....	0	....	s	..	s w	..	s w	..	....	....	.25	......
0	....	0	....	0	....	s	..	s	..	s	..	....	....	....	......
0	....	40	....	80	....	s	..	s w	..	s e	..	....	....	....	......
100	....	50	....	50	....	s	..	s	..	s	..	‡	....	.02	......
80	....	90	....	30	....	s	..	s e	..	s w	..	....	Night.	.25	......
30	....	40	....	20	....	e	..	s	..	s w	..	Day.	....	.19	......
90	....	10	....	100	....	s	..	e	..	s e	..	....	....	.94	......
10	....	90	....	100	....	e	..	s	..	s e	..	§	Night.	.46	......
20	....	90	....	40	....	s w	..	s w	..	s e	..	....	....	.15	......
0	....	0	....	40	....	s	..	s w	..	w	..	....	....	.16	......
60	....	0	....	10	....	s e	..	s e	..	n e	..	....	....	....	......
0	....	0	....	40	....	e	..	n e	..	n e	..	....	....	....	......
10	....	0	....	20	....	e	..	n	..	n e	..	....	....	....	......
855	....	860	....	930	....	...	..	...	..	...	..	....	....	2.63	......
28	....	28	....	31	....	...	..	...	..	...	..	....	....	....	......
		29				...	..	...	..	...	..	....	....	....	......

* Rain in night. † 2:30 thunder storm and hail. ‡ Rain, noon. § Thunder storm 6:30 p. m.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.			Relative humidity or per cent of saturation.			Barometer reduced to freezing point.			Registering thermometer.	
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Maximum.	Minimum.
1......	53	68	59	86	79	88	29.173	29.145	29.171	69	46
2......	60	75	53	82	68	93	29.206	29.219	29.232	53	76
3......	60	79	58	77	66	94	29.254	29.165	29.161	43	80
4......	62	81	58	88	78	94	29.209	29.168	29.214	46	82
5......	57	70	61	87	95	94	29.212	29.151	29.113	71	46
6......	60	74	62	100	95	100	29.135	29.067	28.995	75	56
7......	65	74	60	89	90	100	28.932	28.862	28.852	76	59
8......	62	75	60	88	82	100	28.840	28.790	28.852	85	51
9......	60	72	51	94	80	100	28.829	28.874	28.985	72	55
10......	62	61	51	77	100	100	29.048	29.042	29.133	70	49
11......	47	52	47	85	79	100	29.168	29.162	29.156	54	44
12......	48	61	49	85	71	100	29.095	28 949	28.813	64	46
13......	.....	.....	.....	......	......	......	28.788	28.754	28.818	......	......
14......	.....	.....	.....	......	......	......	28.875	28.897	28.955	......	......
15......	.....	.....	.....	......	......	......	28.983	28.941	28.940	......	......
16......	.....	.....	.....	......	......	......	28.923	....	....	......	......
17......	.....	.....	.....	......	......	......	....	....	....	......	......
18......	.....	.....	.....	......	......	......	....	....	....	......	......
19......	.....	.....	.....	......	......	......	....	....	....	......	......
20......	.....	.....	.....	......	......	......	....	....	....	......	......
21......	.....	.....	.....	......	......	......	....	....	....	......	......
22......	.....	.....	.....	......	......	......	....	....	....	......	......
23......	.....	.....	.....	......	......	......	....	....	....	......	......
24......	.....	.....	.....	......	......	......	....	....	....	......	......
25......	.....	.....	.....	......	......	......	....	....	....	......	......
26......	.....	.....	62	......	......	100	29.041	28.997	28.995	78	......
27......	63	75	56	83	81	100	28.998	28.929	28.918	76	60
28......	70	79	62	80	70	94	28.845	28.742	28.768	80	62
29......	66	85	69	84	72	100	28.780	28.744	28.827	86	66
30......	72	81	63	90	87	100	28.867	....	....	84	63
31......	74	.....	.....	......	......	......	....	....	....	......	......
Sums....	967	1162	919	1375	1293	1657	551.411	550.598	550.898	1278	845
Means...	.....	.....	.....	86	81	97	....	....	....	75.1	52.8
Average.	.....	.....	.....		88		....	....	....	......	......

JUNE, 1903, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.					
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Beginning rain or snow.	Ending rain or snow.	Inches of rain or melted snow	Depth of snow inches.
60	....	100	Cu. St.	90	St.	n e	..	s e	..	n e	..	....	....	....	......
80	St.	20	St.	0	....	e	..	e	..	...	..	....	....	....	......
0	....	0	....	0	....	n e	..	n e	..	...	..	....	....	....	......
50	St.	10	....	20	....	e	..	e	..	n e	..	....	....	....	......
60	....	100	....	40	....	s e	..	s	..	s	..	10 a.m.	....	....	......
100	....	80	....	100	....	s	..	n e	..	s	..	*	....	2.90	......
80	....	100	....	80	....	s	..	n w	..	w	..	....	....	....	......
10	....	20	....	0	....	w	..	n w	..	...	..	....	....	....	......
90	St.	20	Cu.Ci.	0	....	n	..	n w	..	...	..	....	....	....	......
10	St.	70	Nim.	0	....	n	..	n	..	n w	..	†	2 p. m.	.31	......
60	Cu.St.	100	Cu.	100	St.	n	..	n e	..	...	..	....	....	....	......
10	Ci.St.	60	Cu.	60	St.	n	..	n e	..	n	..	....	....	....	......
100	St.	100	Nim.	100	....	w	..	n w	..	...	..	‡	....	....	......
100	....	80	....	80	....	n	..	w	..	...	..	....	....	....	......
40	Ci.	30	....	0	....	n w	..	n	..	...	..	....	....	....	......
100	....	.....	....	.....	....	n w	..	...	..	...	..	....	....	....	......
20	Ci.	.....	....	.....	....	w	..	...	..	...	..	§	....	.25	......
100	Nim.	70	Cu.	.....	....	n	..	...	..	...	..	....	....	....	......
90	....	.....	....	.....	....	...	..	...	..	...	..	12 m.	....	....	......
100	Nim.	100	....	.....	....	n w	..	n	..	...	..	....	7 a. m.	.90	......
10	....	.....	....	.....	....	...	..	...	..	...	..	....	....	....	......
100	Nim.	.....	....	.....	....	e	..	...	..	...	..	Night.	Night.	1.80	......
90	Cu.	.....	....	.....	....	n	..	...	..	...	..	‖	Night.	.12	......
60	Cu.	.....	....	.....	....	n w	..	...	..	...	..	....	....	....	......
10	St.	.....	....	.....	....	w	..	...	..	...	..	....	....	....	......
10	St.	30	Cu.	10	Cu.	w	..	s w	..	n e	..	....	....	....	......
25	Ci.	25	Ci.St.	0	....	n e	..	e	..	...	..	....	....	....	......
0	....	5	St.	0	....	e	..	s e	..	s e	..	....	....	....	......
5	St.	40	Cu.	90	St.	s w	..	w	..	...	..	....	....	....	......
100	St.	100	St.	100	....	s w	..	s w		s w	..	....	....	trace	......
80	....	.....	....	.....	....	w	..	...	..	...	..	....	....	....	......
1670	....	1260	....	870	....	...	..	...	..	...	..	....	....	6.28	......
56	....	57	....	44	....	...	..	...	..	...	..	....	....	....	......
.52												....	....	....	......

* Thunder storm 6 p. m. † Rain 11 a. m. ‡ Max. and Min. Instruments stolen. § Rain in night. ‖ 12:30 p. m.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.			Relative humidity or per cent of saturation.			Barometer reduced to freezing point.			Registering thermometer.	
	7 A. M.	2 P. N.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Maximum.	Minimum.
1......	74	82	70	90	87	100	28.872	28.659	28.784	90	......
2......	73	86	75	90	76	100	28.847	28.869	28.869	86	......
3......	76	87	73	95	84	100	28.944	28.904	28.936	87	......
4......	80	91	74	87	96	100	28.939	28.921	28.967	91	......
5......	69	79	70	95	70	100	29.014	29.039	29.097	79	......
6......	69	83	65	85	71	100	29.203	29.154	29.130	83	......
7......	71	86	70	85	68	90	29.155	29.102	29.039	86	......
8......	74	91	73	81	70	100	29.032	28.946	28.939	92	......
9......	75	90	76	90	80	100	29.017	28.916	28.889	91	......
10......	74	84	72	90	75	100	28.904	28.876	28.904	86	......
11......	70	85	65	95	72	94	28.897	28.809	28.812	85	......
12......	71	77	61	80	69	88	28.832	28.819	28.837	78	64
13......	60	71	55	82	66	100	28.877	28.855	28.875	73	50
14......	59	68	56	88	70	94	28.930	28.877	28.942	72	50
15......	53	72	62	93	76	88	29.030	29.020	29.030	74	43
16......	58	77	59	88	69	94	29.025	28.962	28.977	78	46
17......	68	78	62	84	78	100	28.930	28.839	28.785	81	54
18......	60	70	60	100	85	100	28.655	28.782	28.812	72	57
19......	70	77	64	90	73	100	28.750	28.737	28.755	78	57
20......	60	74	63	100	81	100	28.800	28.820	28.855	76	57
21......	63	68	60	94	95	100	28.887	28.737	28.797	77	53
22......	60	73	61	94	81	94	28.935	28.960	29 007	76	56
23......	64	82	65	94	75	100	29.097	29.079	29.097	82	54
24......	69	86	69	90	72	100	29.148	29.082	29.062	86	57
25......	73	89	69	90	69	100	29.092	28.991	28.984	89	61
26......	71	71	60	95	90	100	29.049	29.079	29.097	74	69
27......	73	75	64	85	86	94	29.145	29.067	29.022	76	49
28......	77	85	75	86	83	100	28.925	28.794	28.697	87	61
29......	70	81	68	100	83	100	28.712	28.684	28.704	82	67
30......	66	71	54	89	71	100	28.780	28.885	29.037	73	60
31......	53	69	54	86	75	100	29.163	29.163	29.173	70	48
Sums....	2103	2458	2024	2791	2396	3036	897.586	896.427	896.911	2510	1113
Means...	.....	.....	.....	90	77	98	....	....	....	80.9	55.6
Average.	.....	.....	.....		88		....	....	....	......	......

JULY, 1903, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Wind.						Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.					
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Beginning rain or snow	Ending rain or snow.	Inches of rain or melted snow.	Depth of snow inches.
80	Cu.St.	100	Nim.	90	Cu.	w	..	s	..	w	..	1 a. m.	3 p. m.	.39	......
30	St.	30	Cu.	100	Nim.	s w	..	n w	..	w	..	*	8 p. m.	.10	......
100	Nim.	40	Cu.	50	Cu.	s w	..	w	..	s	..	....	....	....	......
70	St.	60	St.	100	Nim.	s w	..	s w	..	s w	..	....	....	.215	......
10	Cu.	5	Ci.	0	....	s w	..	n w	..	w	..	....	....	....	......
0	....	0	....	0	....	n w	..	s w	..	s w	..	....	....	....	......
5	St.	0	....	40	St.	s	..	s	..	s w	..	....	....	....	......
20	St.	5	Cu.	50	St.	s w	..	w	..	...	..	....	....	....	......
100	Cu. St.	90	Cu. St.	100	St.	s w	..	w	..	w	..	....	....	....	......
70	St.	100	Cu.	50	Cu.	w	..	w	..	w	..	Night.	....	.17	......
90	Cu. St.	60	Cu.	0	....	n w	..	w	..	w	..	....	....	....	......
0	....	30	Cu.	20	Cu.	n w	..	n w	..	n w	..	....	....	....	......
20	Cu. St.	70	Cu. St.	10	St.	n w	..	n w	..	w	..	....	....	....	......
40	Cu.	40	Cu.	0	....	n	..	n	..	n	..	....	....	....	......
0	....	30	Cu.	0	....	n	..	n w	..	n w	..	....	....	....	......
100	St.	10	Cu.	10	St.	n w	..	n	..	n w	..	....	....	....	......
1	Ci.	100	St.	100	Nim.	s w	..	s w	..	s	..	†	....	1.55	......
100	Nim.	100	St.	0	....	n	..	w	..	...	..	....	....	....	......
0	....	30	Cu.Ci.	100	St.	w	..	w	..	w	..	....	....	trace	......
100	St.	100	Cu. St.	0	....	n w	..	w	..	w	..	....	....	....	......
90	Cu.	100	Nim.	30	St.	w	..	s	..	s w	..	‡	§	.15	......
100	St.	50	Cu.	30	St.	n	..	n w	..	...	..	....	....	....	......
0	....	0	....	0	....	n w	..	n	..	n	..	....	....	....	......
0	....	10	St.	0	....	n w	..	w	..	...	..	....	....	....	......
10	Ci.	70	St.	10	St.	s w	..	w	..	...	..	....	....	....	......
100	Nim.	95	Cu.	40	St.	n	..	n e	..	n	..	Night.	....	.31	......
10	Ci.St.	80	St.	40	St.	n e	..	e	..	s e	..	....	....	....	......
30	Ci.Cu.	90	Nim.	80	St.	s w	..	s w	..	s w	..	....	....	....	......
100	Nim.	75	Cu. St.	100	Nim.	s w	..	w	..	w	..	Night.	....	.90	......
5	Cu.	60	Cu.	0	....	w	..	n w	..	n w	..	....	....	trace	......
90	Cu. St.	50	Cu.	0	....	n	..	e	..	ne	..	....	....	....	......
1471	....	1680	....	1150	....	...	..	...	..	...	..	....	....	3.79	......
47	....	54	....	37	....	...	..	...	..	...	..	....	....	....	......
			46			...	...	...	...	...	...	....	....	....	......

* 6:30 p. m. † 8:30 p. m. ‡ 12:30 p. m. § 1:30 p. m.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.			Relative humidity or per cent of saturation.			Barometer reduced to freezing point.			Registering thermometer.	
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Maximum.	Minimum.
1......	58	74	59	88	72	100	29.228	29.235	29.241	74	45
2......	63	73	61	94	90	100	29.233	29.198	29.193	75	56
3......	66	84	62	100	83	100	29.221	29.080	28.988	85	56
4......	65	72	61	94	90	100	28.900	28.907	28.902	75	63
5......	65	81	67	100	83	100	28.820	28.697	28.752	81	57
6......	68	74	54	90	76	100	28.762	28.825	28.960	75	65
7......	53	68	61	86	79	88	29.080	29.020	28.985	69	41
8......	57	74	63	94	90	100	28.880	28.797	28.772	75	41
9......	62	71	54	94	90	100	28.828	28.870	28.932	72	55
10......	61	78	64	94	82	100	28.938	28.830	28.820	78	48
11......	58	64	53	100	89	100	28.882	28.938	29.003	67	49
12......	53	66	52	100	84	100	29.105	29.070	29.115	67	45
13......	56	71	55	100	85	100	29.135	29 102	29.098	73	48
14......	58	76	58	100	86	100	29.171	29.200	29.130	76	47
15......	59	63	61	94	100	100	29.128	29.055	29.060	66	53
16......	56	76	62	100	82	100	29.098	29.117	29.122	78	52
17......	60	80	62	94	78	100	29.138	29.067	29.082	80	49
18......	67	82	62	89	79	100	28.990	28.907	28.872	82	54
19......	66	76	58	95	91	100	28.855	28.824	28.905	78	61
20......	58	74	58	100	81	100	28.982	28.935	29.000	75	50
21......	63	80	67	94	74	89	28.992	28.880	28.857	80	49
22......	70	72	67	90	95	95	28.990	28.845	28 867	72	64
23......	64	72	62	100	95	100	28.927	28.942	28.935	72	62
24......	62	83	73	100	87	100	28.960	28.862	28.830	85	59
25......	71	81	62	100	87	100	28.880	28.874	28.962	81	71
26......	60	74	62	94	86	100	29.085	29.042	29.055	74	58
27......	59	60	59	100	100	100	28.985	28.928	28.898	61	57
28......	59	61	60	100	100	100	28.885	28.873	28.863	61	58
29......	63	74	59	100	95	100	28.855	28.840	28.823	78	58
30......	61	68	61	100	95	100	28.820	28.843	28.843	70	57
31......	58	64	59	100	94	100	28.935	28.940	28.993	65	57
Sums....	1899	2266	1878	2984	2698	3072	898.688	897.543	897.858	2300	1685
Means...	.....	.....	.....	96	87	99	....	....	....	74.2	54.4
Average.	.....	.....	.....	94			....	....	....	......	......

AUGUST, 1903, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.					
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Beginning rain or snow.	Ending rain or snow.	Inches of rain or melted snow.	Depth of snow inches.
10	Ci.	30	Ci.	0	....	e	..	e	..	...	..	....	....	....	......
100	Nim.	100	St.	40	....	s e	..	s e	..	s	..	....	....	trace	......
100	St.	75	Cu.	100	Nim.	n e	..	s	..	...	..	Night.	....	.78	......
100	Nim.	100	Cu. St.	50	....	n	..	n	..	n e	..	Night.	....	.87	......
100	Nim.	25	Ci.	100	Cu. St.	s	..	w	..	...	..	8 a. m.	9 a. m.	.45	......
0	....	30	Cu.	0	....	w	..	n	..	...	..	....	....	....	......
0	....	40	....	.....	....	n w	..	w	..	...	..	....	....	....	......
100	St.	80	St.	100	St.	s w	..	s w	..	...	..	....	....	....	......
90	Cu.	80	Cu.	0	....	n w	..	n w	..	...	..	....	....	....	......
50	Cu. Ci.	60	Cu.	40	Cu. St.	s e	..	s e	..	s w	..	*	†	.32	......
85	Cu.	100	Ni.Cu.	0	....	n w	..	n w	..	...	..	....	....	....	......
15	Cu.	85	Cu.	0	....	n w	..	n w	..	...	..	....	....	....	......
90	Cu. Ni.	70	Cu.	0	....	...	..	s e	..	e	..	....	....	....	......
0	....	20	Ci.	0	....	s e	..	e	..	...	..	....	....	....	......
100	Nim.	100	Nim.	50	Nim.	s e	..	e	..	n e	..	‡	3 p. m.	.07	......
100	Nim.	30	Cu.	0	....	s e	..	s	..	s w	..	....	....	....	......
0	....	10	Cu.	0	....	s w	..	s w	..	s w	..	....	....	....	......
0	....	15	Cu.	10	Nim.	s w	..	s w	..	s w	..	....	....	....	......
100	Nim.	90	Ni. Cu.	0	....	...	..	n e	..	...	..	....	....	....	......
0	....	70	Cu.	0	....	n e	..	n e	..	...	..	....	....	....	......
20	Ci.	40	Ci.Cu.	0	....	s w	..	s w	..	s w	..	....	....	....	......
60	Ci. Cu.	100	Nim.	100	Nim.	w	..	s w	..	s w	..	....	....	....	......
100	Nim.	100	Nim.	100	Nim.	e	..	s w	..	w	..	**	††	.08	......
100	Nim.	90	Cu.Ni.	20	Nim.	n e	..	n e	..	e	..	2 p. m.	Night.	1.43	......
90	Ni.Cu.	80	Cu.	20	St.	n w	..	w	..	n w	..	Night.	....	.15	......
100	Nim.	80	Ci.Cu.	100	Nim.	n	..	n w	..	n e	..	....	....	....	......
100	Nim.	100	Nim.	100	Nim.	e	..	e	..	e	..	Night.	....	....	......
100	Nim.	100	Nim.	100	Nim.	e	..	e	..	e	..	....	4 p. m.	1.61	......
80	Cu.Ni.	80	Cu. Ni.	0	....	e	..	s e	..	...	..	‡‡	3 p. m.	.42	......
100	Nim.	85	Cu. Ni.	100	Nim.	n w	..	n w	..	n w	..	6 p. m.	....	....	......
100	Nim.	100	Nim.	100	Nim.	n	..	n	..	n	..	....	7 a. m.	.55	......
2090	....	2165	....	1230	....	...	..	...	..	...	..	....	....	6.73	......
67	....	70	....	41	....	...	..	...	..	...	..	....	....	....	......
			59			...	..	...	..	...	..	....	....	....	......

* 4:16 a. m. † 4:50 a. m. ‡ 11:15 a. m. ** 10:30 a. m. †† 4:30 p. m. ‡‡ 6:30 a. m.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air. 7 A. M.	2 P. M.	9 P. M.	Relative humidity or per cent of saturation. 7 A. M.	2 P. M.	9 P. M.	Barometer reduced to freezing point. 7 A. M.	2 P. M.	9 P. M.	Registering thermometer. Maximum.	Minimum.
1......	60	72	57	94	90	100	29.103	29.045	29.078	72	57
2......	62	79	63	94	82	94	29.154	29.112	29.122	80	52
3......	66	82	64	95	75	100	29.108	29.032	29.065	82	57
4......	65	72	60	94	85	100	29.037	29.037	29.117	80	59
5......	55	67	45	93	79	100	29.166	29.140	29.154	66	50
6......	53	66	57	100	89	94	29.189	29.156	29.133	68	38
7......	55	65	60	100	89	100	29.098	29.040	29.003	68	52
8......	66	83	71	89	87	95	28.975	28.992	29.052	84	56
9......	68	76	67	95	91	100	29.067	29.027	28.970	79	64
10......	67	62	51	100	94	100	28.825	28.963	29.053	68	65
11......	57	75	65	94	86	100	29.128	29.097	29.105	75	45
12......	70	85	69	95	76	100	29.072	28.996	28.970	86	63
13......	67	71	69	100	100	100	28.995	29.055	29.027	71	65
14......	72	83	76	95	87	95	29.015	28.964	28.987	83	67
15......	66	83	65	100	87	100	29.030	28.924	28.960	83	65
16......	68	60	50	100	100	100	28.972	28.980	28.983	68	64
17......	45	56	45	100	94	100	28.908	28.983	29.073	57	44
18......	45	54	41	84	87	100	29.169	29.170	29.220	55	38
19......	47	67	54	92	79	100	29.285	29.232	29.200	67	38
20......	58	75	53	82	77	100	29.262	29.204	29.209	75	44
21......	53	78	58	93	82	100	29.224	29.185	29.201	78	48
22......	58	80	58	100	82	100	29.259	29.198	29.128	80	52
23......	62	62	53	88	88	100	28.955	28.918	29.091	74	52
24......	40	53	44	100	86	100	29.131	29.072	29.053	56	33
25......	48	69	60	93	70	77	28.998	28.880	28.880	69	39
26......	61	80	62	82	74	100	28.851	28.760	28.718	81	57
27......	48	54	45	93	74	100	28.911	28.998	29.066	56	44
28......	41	54	43	100	80	100	29.262	29.236	29.244	58	36
29......	46	68	58	84	79	88	29.267	29.223	29.224	70	38
30......	57	72	66	87	80	95	29.192	29.082	29.030	73	51
Sums....	1726	2103	1729	2816	2529	2938	872.608	871.701	872.116	2162	1533
Means...	.....	.....	.....	94	84	98	....	....	....	72.1	51.1
Average.	.....	.....	.....		92		....	....	....	......	......

SEPTEMBER, 1903, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.					
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of clouds.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Beginning rain or snow.	Ending rain or snow.	Inches of rain or melted snow.	Depth of snow inches.
90	Ci. Cu.	35	Cu.	0	....	n	..	n e	..	...	..	....	....	....	......
0	....	70	Cu.	0	....	w	..	w	..	s w	..	....	....	....	......
20	St.	10	Cu.	40	St.	s w	..	s w	..	s w	..	....	....	....	......
85	Ci. Cu.	90	Cu.Nim.	90	Cir.	s w	..	s w	..	n	..	....	....	....	......
90	Cir. St.	0	....	0	....	n e	..	n	..	s e	..	....	....	....	......
5	St.	65	Cir. Cu	95	St.	s e	..	s e	..	s e	..	....	....	....	......
100	Nim.	40	Cu.	90	Cu.	s e	..	e	..	e	..	Night	8:30 a.m.	*	......
30	Cir.	20	Cir. Cu	90	Nim.	e	..	s w	..	s	..	....	....	....	......
100	St. Cu.	90	Nim.	0	....	s	..	s	..	n w	..	Night	....	.01	......
100	Nim.	100	Nim.	0	....	s w	..	s w	..	s	..	7 p. m.	Night	.13	......
0	....	60	Cu.	90	Cu.	e	..	s w	..	s w	..	....	....	....	......
95	Cu.Nim.	35	Cu.	0	....	e	..	s e	..	s	..	....	....	....	......
100	Nim.	100	Nim.	100	Nim.	s	..	s	..	...	..	Night	3 p. m.	.47	......
90	Cu.Nim.	20	Ci. Cu.	100	Nim.	w	..	s w	..	w	..	10 a.m.	11 a. m.	.06	......
100	Nim.	40	Cu. St.	0	....	s w	..	...	..	...	..	Night	†	.48	......
100	Nim.	100	Nim.	100	Nim.	w	..	n w	..	n	..	Night	....	.12	......
100	Nim.	100	Nim.	0	....	n w	..	n w	..	n w	..	Night	‡	.84	......
60	Cir. Cu	90	Cu.	0	....	s w	..	w	..	...	..	....	....	....	......
0	....	0	....	0	....	s w	..	s w	..	...	..	....	....	....	......
0	....	0	....	0	....	s w	..	s	..	...	..	....	....	....	......
0	....	1	Cir.	0	....	...	..	w	..	...	..	....	....	....	......
0	....	5	Cu.	0	....	s	..	s	..	...	..	....	....	....	......
0	....	100	Nim.	0	....	s w	..	s w	..	...	..	....	....	....	......
0	....	80	Cu.	0	....	n w	..	n w	..	...	..	....	....	....	......
10	Cir.	20	Cir.	0	....	s w	..	s w	..	s w	..	....	....	....	......
30	Cir.	10	Cir	100	Nim.	s	..	s	..	s	..	6 p. m.	Night	.61	......
10	Cir.	40	Cu.	50	Cu.	n w	..	w	..	w	..	....	....	....	......
5	St.	40	Cu.	0	....	w	..	n w	..	n	..	....	....	....	......
25	Cir.	0	....	5	Cir.	e	..	w	..	s w	..	....	....	....	......
90	St.	95	Cu. St.	80	Cu. St	s	..	s	..	s	..	4 p. m.	§	.14	......
.....	....	.....	....	.....	....	...	..	...	..	...	..	....	....	....	......
1435	....	1456	....	1030	....	...	..	...	..	...	..	....	....	2.86	......
48	....	49	....	34	....	...	..	...	..	...	..	......	....	....	......
		44				...	..	...	..	...	..	....	....	....	....

* Interfered with. † 7:45 a. m. ‡ 8:30 a. m. § 5:45 p. m.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.			Relative humidity or per cent of saturation.			Barometer reduced to freezing point.			Registering thermometer.	
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Maximum.	Minimum.
1......	66	69	59	95	95	100	29.060	29.022	29.156	72	64
2......	51	59	58	100	94	94	29.266	29.216	29.178	59	51
3......	59	78	61	100	82	100	29.105	28.917	28.915	78	56
4......	59	66	54	94	84	93	28.985	28.985	29.018	67	56
5......	50	64	52	93	89	100	29.108	29.123	29.029	67	46
6......	50	66	66	93	95	95	29.048	28.857	28.740	69	46
7......	69	71	50	90	100	93	28.564	28.489	28.602	71	65
8......	48	55	45	93	93	100	28.666	28.792	28.923	57	45
9......	43	55	46	100	87	100	29.113	29.127	29.186	56	40
10......	38	55	44	91	81	92	29.292	29.211	29.189	57	34
11......	47	52	50	92	93	93	29.175	29.146	29.141	54	38
12......	49	57	45	93	87	100	29.156	29.132	29.176	60	47
13......	39	64	49	91	89	100	29 200	29.095	29.108	66	34
14......	39	66	50	100	84	100	29.078	28.932	28.906	68	36
15......	52	55	54	100	100	93	28.783	28.707	28.730	66	46
16......	54	54	50	93	87	100	28.771	28.750	28.753	59	51
17......	48	46	40	85	92	91	28.627	28.705	28.956	52	46
18......	41	52	45	82	73	84	29.089	28.999	28.934	53	31
19......	43	61	53	92	71	86	28.869	28 792	28.768	63	41
20......	49	64	45	93	83	84	28.878	28.890	29.033	64	46
21......	44	61	48	84	66	93	29.149	29.092	29.033	62	37
22......	53	52	42	80	73	83	28.866	28.938	29.071	60	48
23......	35	47	31	90	8	89	29.156	29.176	29.252	48	33
24......	28	50	42	88	86	100	29.233	29.105	29.039	50	23
25......	38	59	42	91	59	66	28.959	28.929	29.079	59	34
26......	32	43	31	89	75	89	29.288	29.296	29.385	43	31
27......	26	52	44	100	54	76	29.396	29.261	29.206	53	23
28......	40	59	41	91	59	82	29.192	29.110	29.158	60	37
29......	43	65	47	75	40	70	29.149	29.112	29.138	67	38
30......	43	62	52	92	72	93	29.190	29.110	29.130	62	40
31......	48	66	51	85	79	93	29.133	29.112	29.171	68	45
Sums....	1424	1825	1487	2835	2430	2832	900.544	899.128	900.103	1890	1308
Means...	.....	.....	.....	91	78	91	....	....	....	60.9	18.8
Average.	.....	.....	.....		87		....	....	....	......	......

OCTOBER, 1903, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.					
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction	Force.	Beginning rain or snow.	Ending rain or snow.	Inches of rain or melted snow.	Depth of snow inches.
90	St.	95	Nim.	100	Nim.	s		s w		w					
100	Nim.	100	St.	90	St.	n e		n e		s e					
100	St.	10	St.	100	Cu.	s e		s		s w		Night		trace	
80	St.	70	St.	85	St.	w		w		w		*	morning	trace	
100	St.	0		0		w		s w		s e					
15	Cir. St.	100	Cu. St.	30	Cir. St.	s e		s e		s		†	8 p. m.	.53	
70	Cir. St.	100	St.	0		s		s w		s w		10 a. m.	5 p. m.	.87	
95	St.	100	St.	40	St.	s w		w		n w		11 a. m.		trace	
90	St.	60	Cu.	0		n w		n w		n w					
0		0		0		n		n w		n					
0		100	St.	100	St.	n e		n e		n e					
100	St.	20	Cu.	0		n		n w		n w					
5	Cir.			0				n		n w					
0		60	St.	10	St.			e		n e					
100	St.	95	Cu. St.	100	St.	s e		s e		s		10 a. m.	3 p. m.	.61	
100	St.	100	Nim.	100	St.	s w		s w		s w					
85	St. Cu.	40	Cu.	0		s w		s w		n w		1 p. m.	2 p. m.	trace	
30	St.	10	St.	20	St.	n w		s w		s w					
5	Cir.	0		0		s w		s w		s w					
5	Cir.	0		0		n w		w		w					
5	St Cir.	0		0		s e		s w		s					
10	Cir.	80	Cu.	30	St.	s w		w		n w					
100	St.	100	St.	0		n w		s w		n w					
30	Cir. St.	20	Cu. St.	0		w				w					
0		0		0		s w		n w		n					
5	St.	0		0		n w				n w					
5	St.	80	St.	0		s w		w		w					
0		0		0		w		w		s w					
0		0		10	St.	s w		s w		s w					
100	St.	0		100	St.	s		s w		s		10 a. m.		trace	
80	St.	0		60	St.	s w		w		s w					
1505		1340		975										2.01	
49		45		31											
		42													

* 9:30 p. m. † 5:30 p. m.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.			Relative humidity or per cent of saturation.			Barometer reduced to freezing point.			Registering thermometer.	
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Maximum.	Minimum.
1......	52	67	51	100	84	100	29.236	29.178	29.186	69	50
2......	40	69	50	100	90	100	29.195	29.122	29.141	70	39
3......	43	69	51	100	75	100	29.177	29.123	29.141	71	39
4......	47	66	55	92	84	93	29.031	28.890	28.810	70	42
5......	35	39	28	80	64	88	28.886	28.942	29.041	39	35
6......	25	37	25	100	90	......	29.184	29.188	29.262	37	22
7......	22	38	32	100	72	100	29.338	29.260	29.280	40	19
8......	34	56	44	79	63	100	29.296	29.119	29.112	56	27
9......	41	62	52	82	61	86	29.017	28.802	28.738	62	36
10......	39	51	36	82	79	80	28.868	28.832	28.813	51	38
11......	50	52	36	93	100	90	28.520	28.542	28.607	52	34
12......	32	44	41	79	68	82	28.786	28.609	28.650	47	30
13......	31	.....	33	89	......	70	28.986	29.042	29.066	38	29
14......	33	40	36	79	73	90	29.108	29.130	29.140	41	31
15......	33	45	40	89	68	100	29.183	29.051	28.852	45	30
16......	44	41	39	100	100	100	28.645	28.587	28.711	44	38
17......	33	24	17	89	100	100	28.896	28.947	29.097	33	31
18......	16	23	19	100	100	100	29.162	29.204	29.250	23	14
19......	20	22	14	100	100	100	29.325	29.372	29.421	23	18
20......	9	27	20	100	100	100	29.584	29.568	29.553	30	6
21......	24	33	30	100	89	100	29.452	29.273	29.193	34	18
22......	31	41	34	100	91	90	29.073	28.970	28.906	43	28
23......	37	35	29	100	90	89	28.617	28.658	28.899	37	32
24......	27	27	21	100	100	100	29.066	29.115	29.172	30	26
25......	22	25	19	100	100	100	29.162	29.110	29.104	28	20
26......	8	20	17	100	100	100	29.216	29.253	29.253	20	7
27......	20	27	21	100	100	100	29.216	29.102	28.979	27	14
28......	21	25	25	100	100	100	28.765	28.630	28.529	27	20
29......	26	30	27	100	100	100	28.582	28.629	28.730	32	22
30......	24	.....	23	100	100	100	28.896	....	....	31	22
Sums....	864	1135	909	2833	2541	2758	842.572	841.248	841.636	1250	817
Means...	.....	.....	.....	94	88	95	....	....	....	41.6	27.2
Average.	.....	.....	.....		92		....	....	....	......	......

NOVEMBER, 1903, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.					
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Beginning rain or snow.	Ending rain or snow.	Inches of rain or melted snow.	Depth of snow inches.
90	St.	10	Cir. St.	0	....	...	..	...	..	...	..	§	....	....	......
10	Cir. St.	10	Cir.	0	....	e	..	s w	..	s w	..	....	....	....	......
0	....	0	....	0	....	s w	..	s w	..	s w	..	....	....	....	......
100	St.	90	St.	100	St.	s e	..	s w	..	w	..	....	....	....	......
95	St.	100	St.	15	St.	n	..	n	..	n	..	....	....	....	......
5	St.	0	....	5	St.	n	..	s e	..	s w	..	....	....	....	......
5	St.	90	St.	35	St.	s	..	s w	..	s w	..	....	....	....	......
10	Cir.	0	....	0	....	s w	..	s w	..	s	..	....	....	....	......
0	....	5	St.	100	St.	s w	..	s w	..	s w	..	....	....	....	......
95	St.	.....	....	0	....	w	..	...	..	s e	..	....	....	....	......
100	St.	100	St.	30	St.	s e	..	s w	..	s w	..	*	†	.57	......
0	....	100	St.	0	....	s w	..	s	..	s w	..	....	....	....	......
30	St.	100	St.	50	S.	s w	..	...	..	s w	..	....	....	....	......
0	....	5	St.	60	St.	n w	..	w	..	w	..	8 p. m.	Night	.69	......
90	St.	80	Ci. St.	100	St.	s e	..	s e	..	s e	..	....	....	....	......
100	St.	100	St.	100	St.	s e	..	n w	..	n w	..	....	....	....	......
100	St.	100	St.	10	St.	w	..	w	..	n w	..	‡	....	....	.25
5	St.	100	St.	100	St.	s w	..	n w	..	s w	..	‡	....	....	.25
100	St.	100	St.	0	....	n w	..	n w	..	n w	..	‡	....	....	.5
10	St.	60	St.	0	....	s w	..	w	..	s e	..	....	....	....	......
100	St.	100	St.	100	St.	s	..	s	..	s	..	....	....	....	......
10	St.	0	....	100	St.	s w	..	s w	..	s w	..	Night	....	trace	......
100	St.	100	St.	100	St.	w	..	w	..	w	..	....	....	....	......
100	St.	100	St.	20	St.	n w	..	n w	..	n w	..	....	....	....	......
95	St.	100	St.	100	St.	w	..	n w	..	n w	..	....	....	....	......
10	St.	0	....	100	St.	n	..	w	..	w	..	....	....	....	......
100	St.	95	St.	10	St.	s w	..	s w	..	s w	..	....	....	....	......
100	St.	100	St.	100	St.	s w	..	s	..	s w	..	‡	....	....	1.00
100	St.	100	St.	80	St.	s w	..	w	..	w	..	....	....	....	......
95	St.	.....	....	10	St.	w	..	...	..	w	..	....	....	....	......
17.55	....	18.45	....	14.35	....	...	..	...	..	...	..	....	....	....	2.00
59	....	64	....	48	....	...	..	...	..	...	..	....	....	....	......
57						...	..	...	..	...	..	....	....	....	......

* 5:30 a. m. † 6:30 p. m. ‡ Snow all day. § Heavy fog all night.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.			Relative humidity or per cent of saturation.			Barometer reduced to freezing point.			Registering thermometer.	
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Maximum.	Minimum.
1......	21	48	21	100	100	100	29.101	29.077	29.134	28	11
2......	7	29	15	100	100	100	29.179	29.102	29.077	31	5
3......	20	29	31	100	100	100	29.006	28.912	28.914	31	10
4......	29	27	23	100	100	100	28.928	28.924	28.962	31	27
5......	22	27	22	100	100	100	29.045	29.088	29.042	28	19
6......	24	30	28	100	100	100	29.079	29.007	28.905	30	20
7......	30	32	31	100	100	100	28.738	28.830	28.957	32	25
8......	26	26	23	100	100	100	29.007	28.974	28.897	27	25
9......	24	32	26	100	100	100	28.812	28.682	28.596	32	22
10......	21	30	26	100	100	100	28.569	28.624	28.747	30	20
11......	15	21	18	100	100	100	28.791	28.880	29.002	21	14
12......	21	35	22	100	100	100	28.815	28.557	28.799	35	17
13......	4	7	2	100	100	100	29.158	29.192	29.258	10	3
14......	11	12	10	100	100	100	29.238	29.281	29.248	12	—3
15......	11	18	6	100	100	100	29.218	29.163	29.140	18	8
16......	13	20	9	100	100	100	29.077	29.047	29.122	20	5
17......	20	25	11	100	100	100	29.162	29.176	29.217	25	8
18......	16	26	22	100	100	100	29.268	29.193	29.133	27	9
19......	2	35	35	100	100	100	....	....	....	35	22
20......	32	33	30	100	100	100	29.564	29.604	28.602	35	24
21......	30	35	20	100	100	100	28.579	28.459	28.639	38	15
22......	17	34	16	100	100	100	29.048	29.050	29.060	35	15
23......	22	40	26	100	100	100	29.030	29.020	28.962	41	20
24......	33	35	17	100	100	100	28.795	28.645	28.670	35	10
25......	12	15	7	100	100	100	28.614	28.575	28.724	15	—2
26......	0	10	6	100	100	100	28.986	28.930	28.772	19	—9
27......	19	17	9	100	100	100	28.509	28.718	28.968	19	4
28......	12	19	20	100	100	100	29.140	29.035	28.882	22	11
29......	21	16	16	100	100	100	28.827	28.850	28.995	23	0
30	8	15	14	100	100	100	29.113	29.010	29.032	20	7
31......	17	20	18	100	100	100	29.024	28.832	28.970	22	10
Sums....	560	798	580	......	......	......	869.420	868.437	868.426	827	374
Means...	.....	.....	.....	......	......	......	....	....	....	26.7	12.1
Average.	.....	.....	.....		100		....	....	....	......	......

DECEMBER, 1903, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.					
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction	Force.	Beginning rain or snow.	Ending rain or snow.	Inches of rain or melted snow.	Depth of snow inches.
100	St.	100	St.	100	St.	s e	..	s w	..	s	..	....	....	....	......
5	St.	0	....	0	....	s e	..	s e	..	s e	..	....	....	....	......
100	St.	100	St.	100	St.	s e	..	s e	..	s e	..	....	....	....	......
100	St.	100	St.	100	St.	s w	..	s w	..	s w	..	....	....	....	......
100	St	100	St.	100	St.	s w	..	s w	..	s w	..	....	....	....	......
100	St.	5	Cir.	85	St.	s w	..	s w	..	s w	..	....	....	....	......
100	St.	100	St.	100	St.	s w	..	n w	..	s w	..	....	....	....	......
100	St.	100	St.	100	St.	e	..	n e	..	s e	..	*	12 m.	....	.5
100	St.	100	St.	100	St.	s e	..	s e	..	s e	..	†	10 a. m	....	1.0
100	St.	......	....	100	St.	n w	..	s w	..	s w	..	....	....	....	......
100	St.	100	St.	90	St.	s w	..	s w	..	s w	..	‡	....	....	1.0
100	St.	100	St.	100	St.	s e	..	s	..	w	..	§	Rain	.10	5.0
90	St.	30	Cu.	0	....	n w	..	w	..	w	..	†	....	....	2.0
100	St.	0	....	100	St.	w	..	w	..	s w	..	Snow	....	....	......
100	St.	100	St.	0	....	n w	..	n w	..	s w	..	Snow	....	....	......
20	St.	0	....	0	....	s w	..	s w	..	s w	..	....	....	....	......
100	St.	0	....	20	St.	n w	..	n w	..	w	..	....	....	....	......
95	St.	80	St.	90	St.	s	..	s	..	s	..	....	....	....	......
100	Nim.	100	Nim.	100	Nim.	s	..	s	..	s w	..	‖	**	....	1.2
100	Nim.	100	St.	90	St.	n w	..	n	..	n	..	....	6 a. m.	....	......
80	St.	100	St.	100	Nim.	s	..	s	..	w	..	†	....	....	trace
10	St.	100	Nim.	0	....	w	..	s w	..	s w	..	Snow	....	....	trace
0	....	10	....	0	....	s w	..	s w	..	s w	..	....	....	....	......
100	Nim.	100	St.	80	St.	s	..	s w	..	s w	..	††	‡‡	....	trace
80	St.	100	Nim.	0	....	s w	..	n	..	n w	..	10 a. m	5 p. m.	....	.5
40	St.	90	St.	100	Nim.	w	..	w	..	n w	..	Snow	....	....	trace
100	Nim.	80	Nim.	0	....	n w	..	n w	..	n w	..	Snow	....	....	trace
100	St.	50	....	100	St.	s	..	s	..	s	..	Snow	....	....	2.75
100	Nim.	100	Nim.	30	St.	s w	..	w	..	s w	..	10 a. m.	3 p. m.	....	3.0
100	St.	100	Nim.	100	Nim.	s w	..	s	..	s	..	Snow	....	....	.5
100	St.	100	St.	100	....	s w	..	s w	..	w	..	Snow	....	....	trace
2620	....	2245	....	2085	....	...	..	...	..	...	..	....	....	....	17.45
85	....	72	....	67	....	...	..	...	..	...	..	....	....	....	......
75						...	..	...	..	...	..	....	....	....	......

* Snow 7 a. m. † Snow night. ‡ Snow all day. § Snow during night. ‖ Rain 6 a. m. ** Snow 6 a. m. †† Rain 3 a. m. ‡‡ Snow 10 a. m.

BULLETINS

OF THE

AGRICULTURAL COLLEGE EXPERIMENT STATION

ISSUED DURING THE

YEAR ENDING JUNE 30, 1904

EXPERIMENT STATION BULLETINS.

DIVISION OF CHEMISTRY—BREAKFAST FOODS.

BY FLOYD W. ROBISON,

Bulletin No. 211.

INTRODUCTORY NOTE.

The analytical data appearing in this bulletin have been in preparation for two years as time would allow. Not all the cereal breakfast foods were examined but only such as were obtainable in our markets. It is believed that types of all or nearly all classes are shown in this report.

In presenting this bulletin to the public, it has been considered advisable to divide the matter into two parts: part one to be a short popular discussion of the Compounds and Laws of Nutrition, and part two to consist of the more or less technical analytical data and the deductions therefrom, together with an appendix showing some of the methods of analysis.

PART ONE.

THE COMPOUNDS OF NUTRITION.*

- Food.
  - Inorganic matter
    - Water: Oxygen. Hydrogen.
    - Mineral matter: Oxygen. Sulphur. Chlorine. Phosphorus. Potassium. Sodium. Calcium. Magnesium. Iron. Silicon. Manganese. Fluorine.
  - Organic matter
    - Nitrogenous or protein
      - Proteids, Albuminoids, Simple nitrogen bodies: Carbon. Oxygen. Hydrogen. Nitrogen. Sulphur. Phosphorus. Iron.
    - Non-nitrogenous
      - Fats, Carbohydrates, Cellulose, Organic acids, Organic salts: Carbon. Hydrogen. Oxygen.

---

* Adapted principally from a chart in "The Feeding of Animals," by Jordan.

As will be seen from the above, food products are exceedingly complex substances. The compounds of greatest significance, however, are the *inorganic compounds*,—water and mineral matter, and the *organic compounds*,—proteids, carbohydrates, cellulose and fat. These materials make up the bulk of all food products.

WATER.—Water is present in all foods in varying amounts and is of exceeding great importance in human and in animal nutrition. If it were not for water, no food could be utilized, for the reason that it is the medium by means of which food is conveyed to the tissue. Johnson has said, and very truthfully, that "next to temperature water is the most potent factor in the production of a crop," and what is true of water in relation to plant growth is likewise true in relation to animal nutrition. Water might well be called the great lubricator of the digestive system, and it is certainly because of the presence of water that foods can be absorbed by the body. All plant tissue, and all animal tissue, contains a considerable amount of water. All foods, in their ordinary condition, contain more or less water. The porterhouse or round steaks, as purchased in the market, contain over sixty per cent water, and vegetable products and cereal goods also contain more or less of this substance. Water is the medium for the transportation of food from one part of the body to another, and in a similar way is also the carrier of the waste products from the body. An animal may exist for some time without food, but will not, if deprived of water.

MINERAL MATTER.—The mineral matter of a food is that part which remains unconsumed when the food is burned. It is, as a rule, the smallest portion of the food and occupies a somewhat minor place in animal nutrition. It is the mineral part of the food which serves to build up the bony framework of the body, and it seems to be indispensable to the normal action of the blood and the digestive fluids. It is generally considered that some care should be given to the food of growing children from the standpoint of mineral matter, for the framework of their bodies is being constantly enlarged and strengthened, and this supply must come from the mineral matter of the food. Foods vary greatly in the amount of mineral matter they contain. As we might expect, the mineral matter in cereals is present to the greatest degree near the surface of the kernel and hence the most of it is removed in the process of milling and appears in the waste products. The bran from wheat therefore, should contain a higher content of mineral matter than the flour from the same wheat. In fact bran contains on the average about ten times as much mineral matter as does the fine flour. Excepting nitrogen, a crop robs the ground on which it is grown principally to the extent of the mineral matter which it removes. The immense amount of starch and sugar present in all crops did not cost the land a single pound of real nutriment for it contains neither nitrogen nor mineral matter, however, were it not for the presence of mineral matter in the soil not a single grain of starch could be formed. Similarly, in human bodies, the total amount of ash or mineral matter is quite small, and a large amount in the food is not desirable. At the same time the presence of a certain minimum amount is quite necessary for it is closely associated with the utilization of the other factors in the food.

THE PROTEIDS.—It has been customary to consider the proteids as the most important substances concerned in the nutrition of man and animals. Certain it is that none of the life processes go on in the absence of proteids. In what forms they exist in the body is not known, but living tissue, when subjected to analysis, always yields proteids. Proteids are the substances in the food least understood. They differ essentially from the fats and carbohydrates in that they contain nitrogen. It is not in place here to discuss the various compounds coming under this head, suffice it to say that the albumen of eggs, gluten of flour, casein of milk and lean meat, are typical forms of proteids. It is highly essential that the food of man shall contain considerable proteid substance, for the latter seems to be quite intimately related to the life processes of the body.

FATS.—Fats are substances which, as will be seen from the table, contain simply carbon, hydrogen and oxygen. From this it might seem that they are simple substances, but such is not the case. Fats from different sources vary quite widely in the proportions of these three elements. In chemical terms, fats are combinations of glycerine with organic acids. They are insoluble in water, but easily soluble in ether and gasoline. On treatment with alkalies they may be converted into soaps, and glycerine may be obtained as a by-product. The fats

in the body are chiefly *olein*, *palmitin* and *stearin*. They are supposed to be fluid or semi-fluid in the body, because at the same temperature, outside of the body, they become fluid. The body temperature is 37½° C., whereas these fats in the combination in which they are found in the body become fluid at about 25° C.* These three fats melt at different temperatures, thus olein melts at —5° C., palmitin at +45° C., and stearin at about +55° C. In the intestines the fat of the food is acted upon by the bile and pancreatic fluids which convert some into soap and more into an emulsion in which conditions it is supposed to be absorbed.

CARBOHYDRATES.—The carbohydates of the food, like the fats, contain carbon, hydrogen and oxygen only. In the carbohydrates, however, the hydrogen and oxygen have a certain constant ratio to each other. They are found always in the same proportions as in water, that is, two parts of hydrogen to one part of oxygen. Typical examples of carbohydrates are *sugar*, *starch* and *dextrin*. So far as the chemical composition of the carbohydrates is concerned, they could be formed by uniting carbon with water, and it is thought that this may be really what nature does in the leaf of the plant,—which is the laboratory where carbohydrates are formed. All the carbohydrates conform to the general formula CH_2O. There are several products coming under this head which, in some respects, are quite similar and yet are the results of different processes and are in reality quite different products. Among these are *starch*, *dextrose*, *maltose*, *lactose*, *cane sugar* and *dextrin*. These are all carbohydrates. All have formulae nearly identical, yet in action they are essentially different. They may be changed artificially from one form to another in some cases, and nature seems to be able to so change them quite readily.

Starch—$(C_6H_{10}O_5)n$ has quite a definite structure in the plant—varying slightly in different plants—and quite uniform in physical appearance. It is white, non-crystalline in appearance, and insoluble in water. It is very abundant in vegetable foods, constituting on the average over fifty per cent of the total dry matter. It is therefore a useful animal food. Starch is acted upon in the system by the diastase of the intestines and converted into maltose. By the action of dilute acids it may be converted (hydrolized) into *dextrose* (glucose) or *grape-sugar*—a point upon which the glucose industry depends. While starch in the raw state is insoluble in water, when boiled for a considerable time it is rendered soluble. It is supposed that the starch granule is protected by a wall or layer of cellulose which does not yield readily to the action of the diastasic ferments.† Boiling, it is thought, may burst this cellulose layer and set the starch granule free. This view is supported by the fact that it is possible to render starch soluble also by grinding for a long time in a mortar which, likewise, must rupture the cellulose layer.

Dextrose—$(C_6H_{12}O_6)$ or grape sugar is found in nature in fruits and honey. It is a term synonymous in these later days, with *glucose*. It is thought that before being dissolved in the blood, starches and sugars are changed into dextrose. This may be accomplished by a ferment in the intestines called *invertin*. Dextrose is not a product of the action of diastase on starch but is the result of the action of invertin on maltose. It is also the sugar which is present in considerable quantities in the blood and urine of diabetic patients.

Maltose—$(C_{12}H_{22}O_{11})$ or, malt-sugar is the chief end product of the action of the diastase ferment on starch. In the preparation of beer the maltose is produced by the action of the diastase on the barley starch which is thus changed into a product (maltose), which by the action of yeast is converted into alcohol. This same action goes on in the intestines except that the process stops with the formation of maltose.

Lactose—$(C_{12}H_{22}O_{11})$ or milk-sugar has the same chemical formula as maltose but is quite a different product. It is not so sweet as the other sugars and appears much like starch. It is soluble, however, in water and is the carbohydrate found in milk. It is present in milk to the extent of about five per cent, and is the sugar which by its transformation into lactic acid, makes possible the souring of milk.

Cane Sugar—$(C_{12}H_{22}O_{11})$ or granulated sugar, is the most important sugar of commerce. It is not present in cereals in large quantities, but is found in abun-

*Halliburton.

†See Halliburton's Text-book of Phys. and Path. Chem. There are differences of opinion on this point, but nothing, of an opposing nature, has been established and this article will adhere to the above opinion.

dance in sorghum, sugar cane, sugar beets and maple sap, having the same formula and properties from each of these various sources. It may be changed into *glucoses* by the action of *invertin* and may then be further changed by yeast into alcohol.

Dextrin—$(C_6H_{10}O_5)_n$ is a product supposed to be intermediate between starch and maltose. It is always produced when diastase acts on starch outside of the body, but the amount produced in this way seems to depend largely on the temperature to which the mass is submitted. It may be changed further into some of the glucoses. Dextrin is used extensively as a base for the manufacture of mucilage and differs from starch in being soluble in water. Starch, if heated for a considerable time is gradually changed to dextrin.

Cellulose—$(C_6H_{10}O_5)_n$ or fiber is a carbohydrate of the same chemical composition as starch, but it is a decidedly different product. It is a colorless, insoluble material composing the cell walls and woody fiber of plants. In the human system the various ferments seem to have difficulty in dissolving it and hence we are in the habit of cooking foods containing much fiber, so that the fluids of the body may get to the starchy material supposed to underlie the cellulose layers. The fiber or cellulose exists mostly in the rough, outer covering of the grain. In fact it may be said with truth that the fiber and mineral substances inhabit for the most part the same portions of the vegetable food products.

LAWS OF NUTRITION.

To illustrate fully and clearly the data presented in this bulletin we shall discuss as briefly as possible some of the essential points concerned in the nutrition of man.* In discussing this subject we must look at the problem from two standpoints, first from the standpoint of the machine, and second from the physiological standpoint. These two views in some instances are antagonistic.

Man is first of all a machine. His first duty, naturally, is to provide fuel for the maintenance of his bodily mechanism. What he eats in excess of this may fittingly be of a nature that conforms to his physiological and social surroundings, without special regard to its properties from the standpoint of nutrition. Food is supplied to the body then primarily as a fuel to maintain the temperature of the body and to furnish energy for bodily work. In this respect the comparison of man to an engine and of his food to the fuel supply of the boiler is a very apt one. Fuel is supplied to maintain the temperature of the boiler so that steam may be produced and work be done. Exactly in the same way, food is taken by man in order that his bodily heat may be kept up and the life processes may go on. Every contraction of muscle, even the beating of the heart and that concerned in the process of breathing requires the combustion of food material already in the body and food must be supplied from outside sources or these life processes are, of necessity, of short duration. The body, if unable to procure food or fuel from external sources, draws upon the stored up supply in itself, as in sickness, and the person is then said to "consume his own flesh."

A food is any substance which, taken into the system, builds tissue or yields energy which is of use in the performance of natural functions.†

To be a food, from a mechanical point of view, the substance must be capable of yielding energy, that is, it must be in a condition in which it can be burned in the body to produce heat and muscular activity. Foods are classified, mechanically, according to their heat producing powers in exactly the same way that fuels for a boiler are classified.

Chemistry recognizes six general divisions of all foods, namely:

1. Protein—(gluten, albumen, casein, etc.).
2. Fiber—(cellulose).
3. Carbohydrates—(sugars, starch, etc.).

---

*It is exceedingly difficult to describe in non-technical language the principles of human nutrition, and while the discussions herein given are not very extended, possibly they may give to the average reader a somewhat clearer understanding of those laws. It may be well to state here that the author has felt for some time that altogether too much stress is laid on the concentrated food idea and what observations he has been able to make, together with a study of the nutritive processes as influenced by different foods have quite inclined him to believe that in the human system, at least, it is not so much the digestibility of the food that determines its value in the dietary, as its wholesomeness as influenced by compounds not considered, necessarily, as concentrates which are present and which in themselves may not be highly nutritious.

†See "Bunge" Physiologic & Pathologic Chemistry, Chap. IV.

4. Fats—(lard, tallow, butter, oils, etc.).
5. Ash—(mineral matter).
6. Water.

The first three of these from the standpoint of fuel have nearly the same value,* that is, when a given weight of each is burned in the body it furnishes nearly the same amount of heat. Protein has a slightly higher value than have the other two. The fourth one,—fats, however, is as much more valuable than the first three for fuel as hard coal is more valuable than wood. It liberates more heat, and the inhabitants of the Arctic countries unconsciously recognize this fact when they relish so much fat and oil in their daily food. Fats are worth, for this purpose, about twice as much as the carbohydrates. The mineral matter or ash and the water in a food have no value as heat producers. Pound for pound then, as a source of heat and energy, starch and sugar, are worth nearly as much as is lean meat (protein). From this standpoint alone starchy foods are much more economical than the concentrated protein foods, commercially the starchy foods being much cheaper than the protein foods.

There is also a physiological side to view. A food to be a perfect food must not only yield energy but it must also repair waste tissue and it is always in the presence of the protein compounds that this phenomenon is accomplished. In the average man at ordinary work there is wasted or used up about three and one-half ounces of protein per day† and this amount must be made up or supplied in the food or the physiological processes of the body will not be normal. Independent then of the fuel supply of the body must be this three and one-half ounces of protein to replace waste tissue caused by the performance of the natural, normal, physiological functions of the body. After this amount is supplied it is then a matter of economy to secure the balance of the requisite fuel where it can be obtained the cheapest, and naturally that place would be among the carbohydrates and fats. The science of a balanced ration is to furnish the expensive protein only so far as it is needed, and to make up the bulk or main fuel supply from the much less expensive carbohydrates and fats.

Not all of the food that enters the system is utilized in the body.‡ There is a certain amount that always escapes digestion and assimilation because of the condition in which it exists.§ The nutriment may exist in the food but it may be so incased in the cellulose wall that the fluids of the body are unable to get to it. Hence we say that one food is more completely digestible than another. This holds true especially with regard to foods containing a considerable amount of fiber. Entire wheat flour, for example, is less digestible than high grade patent flours,|| possibly because of the larger amount of fiber in the entire wheat, making it more difficult it would seem for the fluids of the body to dissolve the nutriment. For the same reason such foods as whole wheat bread really furnish less energy to the body than white bread, for greater effort is required of the system to digest it, and as a consequence the body material used up in this effort must be much greater than with white bread. In other words, the cost of digestion of white bread must be less than with whole wheat bread and therefore the net energy furnished by white flour would be greater, it would seem, than by whole wheat flour.**

There is however, another point of view—one not usually mentioned but surely as logical and just as pertinent. It is well known how essential it is that the food of cows, sheep and horses contain considerable fiber or roughage. Feeding the heavier concentrates without roughage would be liable to cause impaction of the intestines. While in man the intestine is much shorter, at the same time some bulk is desirable for exactly the same reasons that we feed roughage to the animals. The major part of the cellulose in wheat is in the bran,†† and that is the part rejected in preparing our high grade patent flour. Whole wheat flour contains some of the bran and hence more fiber than exists in patent flour from

*Bul. 13, part 9, U. S. Dept. of Agr., pp. 1245–1249.
†Bunge, Chap V.
‡It is a well established fact that foods vary in the degree of digestibility and furthermore that various conditions, such as palatability, preparation of the food, etc., have considerable influence on this factor.
§This refers especially to vegetable foods. It is believed that meats, well prepared, and milk, etc., are more or less completely digested.
||See Bul. U. S. Dept. of Agr., Office of Expt. Sta. Studies on Bread and Bread-making by Snyder.
**See Armsby-Principles of Animal Nutrition.
††Wheat contains 1.8% fiber while bran from the same wheat contains 9.0% fiber. See Henry's Feeds and Feeding.

which white bread is made. Every one who has been concerned with the feeding of animals knows well the laxative effect of bran on the dairy cow and on the horse. There seems no reason to dispute the inference that its effect on man will be, in a measure the same. The human system has a very delicate digestive mechanism which it is to our highest welfare to keep in proper condition. Crowding into the stomach, foods, which contain no fiber or ballast even though highly digestible* and economical, is an evil the magnitude of which has not been sufficiently realized. No particular nutritive value is claimed for fiber or cellulose in the human dietary,† but it favors the onward movement or the products in the alimentary canal and in this way tends to keep the system in a healthy tone. It has been shown that in some animals living on vegetable foods, life for a great length of time was impossible without considerable fiber in the food,‡ and it certainly seems rational to assume that man will be benefited if a certain amount of fiber exists in his food.

As mentioned in Part Two, undoubtedly the original purpose of the modern breakfast foods was to correct the evils due to faulty nutrition and hence they were intended primarily for invalids. The first requisite of such a food was that it should be well cooked. After this it was subjected to the action of a ferment by means of which the starch was converted into sugar and dextrin. In this way it was said to be *predigested.* The normal process of digestion should begin with the food in the boiler on the stove where it is cooked for a long time until the starch granules have burst the cellulose wall enclosing them and are in a condition fit for solution in the body fluids. The first real act of digestion begins in the mouth where the cooked food is mixed with the saliva and because of the diastasic ferment there present a slight amount of the starch is changed to maltose (sugar) and dextrin. This process goes on for a time after reaching the stomach until the acidity of the gastric juice stops it. The next scene of action is in the small intestine where the remaining starch is converted into sugar and in this condition is absorbed by the blood. Food containing raw starch, when taken into the system, is not easily acted upon because it is thought the cellulose wall protects the starch. Such foods besides being of small value, because of the fact that their starch is not readily available are frequently a positive harm for the reason before mentioned that delayed in their passage down the food canal, fermentations may set up which seem not in harmony with the natural digestive processes and indigestion with all its accompanying ills may be a result. No one will think of eating uncooked oatmeal and wheat. On the other hand breakfast foods of the so called predigested type are supposed to be thoroughly cooked and predigested in that the starch has been changed into malt sugar whereas the facts really are that they have been predigested in the majority of cases to but a slight degree§ and, if taken into the system without further cooking, constitute a constant source of danger from indigestion. An inspection of the analyses in the tables following will show to what extent predigestion has been carried on. It will be seen that in the major number of cases it has not been carried very far. It is hard to see how it can be true, as claimed that these foods are more nutritious than wheat bread, yet they are as a rule more expensive.|| That they have a field when properly prepared is not disputed but their original scientific foundation does not hold with the large number of breakfast foods now on the market and their extravagant claims** have thrown them, it would seem in some instances, wide from the truth. The public will do well not to rely for guidance on the claims of the manufacturer as printed on the package, many of which claims are without any reasonable foundation.

---

*See note, page 10—Snyder.
†See Halliburton Text-book on Physiological and Pathological Chemistry Cellulose.
‡Bunge, Chap. V., pp. 71–72.
§See Table III. Insol. Starch.
||Table I. Comparative amounts obtained for 10 cents.
**See page 15.

PART TWO.

It is well understood, by physicians, that quite a large per cent of ailments and diseases of mankind are primarily due to faulty nutrition. It is a very common thing to meet a person suffering from disorders of the stomach or other alimentary organs, more or less directly traceable to the food consumed. Food either is not well prepared or such great haste is made in eating that it enters the stomach in a wholly unfit condition. Here, because of improper preparation, the digestive fluids of the body are unable to break it down easily, and putrefactive fermentations are liable to set in, resulting in the production of toxic substances, which bring about a condition known as autointoxication as a result of which the blood becomes overloaded with refuse and poisonous material. Improperly cooked foods, too concentrated foods and hasty eating, it would seem, all may combine to favor this condition.

THE ORIGINAL BREAKFAST FOOD.

Modern breakfast foods or the so called predigested foods were undoubtedly manufactured, originally, to ameliorate to some degree, this condition, and in some respects that end has been accomplished. But in this class of goods, as in many others, the original purpose, in most cases, has been lost sight of, consequently the name or brand now has comparatively no significance, and many of the claims seemingly, are not well taken.

Much effort has been made, of late, by scientists to put the nutrition problems of man on a scientific basis, and their success is shown, in a degree by the prevalence of certificates of analysis on the outside of packages. It is an easy thing to print a chemical analysis on the outside of a package, but it is quite another thing to place thereon an analysis that gives one an insight into the value of that food from a nutritive standpoint. It is a common thing to see a breakfast food package nearly covered with technical statements relating to its good qualities, statements frequently misleading and sometimes quite fallacious.

DISCUSSION OF RESULTS.

Table II shows a complete analysis of the different foods examined. A glance at the column headed "crude protein" shows that there is a considerable amount of variation in this constituent. It will be noticed that by far the greater part, of these cereal products, consists of the carbohydrates which includes the starches, sugars and dextrin. It is this latter class that is altered in the treatment or so called predigestion of the food. The analyses given in Table II may be taken as representing, in a degree, the condition of the food before treatment,—the carbohydrates being then practically all starch.* After treatment the total amount of carbohydrates is the same except, that some of the starch has been changed to sugar and dextrin, and then appears (in Table III) under the heading "soluble in water." It will be noticed again (in Table II) that the oatmeals contain much more protein than do the wheat products. Protein is the most expensive compound in food stuffs, and hence from the standpoint of protein the superiority of oatmeal is apparent. It should also be observed that oatmeal, or the oat products, contain more fat than do the products from wheat, and for this reason also it is superior. These two facts are rendered apparent in the column headed "fuel value,"† for here the different foods are compared with reference to their heat producing values and as we should naturally expect from the above, rolled oats, or oatmeal, leads as a source of fuel. The fuel value as computed on the following basis which has been demonstrated to be substantially correct.‡

Protein	5,900	calories per gram
Fiber	4,200	" " "
Fat	9,300	" " "
Carbohydrates	4,200	" " "

*Of course in the original condition before treatment there are some carbohydrates present, other than starch, such as the Pentose carbohydrates, etc., but starch constitutes by far the major portion.

†The fuel value of a food stuff as determined by the calorimeter is higher as a rule than when burned in the body, hence it is not strictly correct to take, as thoroughly accurate, the values as determined by the calorimeter.

‡Bul. 84 Internal Revenue Dept. Ottawa.

On the above basis the foods in Table II were computed. To illustrate we will compare No. 129 Pettijohn's Breakfast Food with No. 130 Quaker Rolled White Oats.

No. 129—Pettijohn's Breakfast Food:

Protein	12.11%x59	equals	714.49	calories
Fiber	2.30%x42	"	96.60	"
Fat	2.50%x93	"	232.50	"
Carbohydrates	71.08%x42	"	2985.36	"
Moisture	10.43%x0			
Ash	1.58%x0			
Total	100.00%	"	4028.85	"

No. 130—Qaker Rolled White Oats:

Protein	17.55%x59	equals	1035.45	calories
Fiber	2.40%x42	"	100.80	"
Fat	7.20%x93	"	669.60	"
Carbohydrates	61.66%x42	"	2585.52	"
Moisture	9.40%x0			
Ash	1.89%x0			
Total	100.00%	"	4391.37	"

The fuel value of Quaker Oats is	4391.37	calories per gram
" " " " Pettijohn's food is	4028.85	" " "
Balance in favor of Quaker Oats	362.52	" " "

The term calories as used above is simply a technical term used to designate a certain amount of heat. It is sometimes called a heat unit and really means the amount of heat required to raise one gram (15.5 grains) of water through a temperature of one degree centigrade. (1 4-5° Fah.)

Table III deals with that which is soluble and insoluble in water. Of course the object of digestion is to convert the insoluble food into a soluble substance so it may be dissolved by the blood. The column headed "protein" in this table, while referring to the amount of nitrogen compound soluble in water, at the same time does not indicate that these nitrogen compounds have been to any extent predigested. In fact qualitative tests failed utterly to show peptone, the presence of which would have been an indication of the partial digestion of the protein. Where there has been any predigestive action it has been confined entirely to the starch. The columns headed "sugars and dextrin" show to what extent this predigestion has been carried on. The column headed "soluble starch" shows to what extent cooking has rendered the starch soluble. It should be observed that, aside from what has been converted into sugar and dextrin very little is left as free soluble starch. Further, a glance at the column headed "insoluble starch" will show that in the majority of cases but little of the starch has been changed. The exceptions clearly show in the table. The natural process that starch goes through in the system, and the process some of these prepared foods have gone through, is a malting process, by means of which, owing to the action of a peculiar ferment,* the starch is converted into a malt-sugar (maltose). It should be noted, in this respect, that malt-sugar and not grape-sugar is the end product of the action of this ferment. Hence malt-sugar, not grape-sugar, is naturally present in these malted foods. Grape-sugar is a term synonymous with glucose, and it is safe to say, that if much grape-sugar is present, it is present as an added and not as a natural product. Indeed, qualitative tests failed to show the presence in appreciable amounts of grape-sugar or glucose. There are a few foods, which as yet we have not had the opportunity of fully examining, that do contain considerable grape-sugar but, as said before, it has been added in the form of commercial glucose. A claim therefore that grape-sugar is the sugar present, is based wholly on a wrong interpretation of the malting process or else it is a confession of the addition of commercial glucose to the product.

As these products have been placed in competition with some of our staple articles of food such as meats, wheat bread, etc., Table IV and Table V are inserted to compare some of them purely from the mechanical or fuel standpoint.

*Diastase Ferment.

Such statements as the following are made,—"One package (one pound) is equal to four pounds of oatmeal in nutriment," Another, "This food is particularly recommended for nursing mothers to increase the quantity and quality of the breast milk," etc. Another, "This is a condensed food, about four heaping teaspoonfuls being sufficient for the meal," etc. "One pound of this food is equal to ten pounds meat, wheat, oats," etc.*

The above are, simply, examples of the arguments presented and statements made in the abundance of literature accompanying these foods. It seems quite impossible to place any reliance on such statements. It is to be regretted that anxiety to create a market for these goods seems to lead the manufacturers to depart so widely from the exact facts. Most of the breakfast foods are manufactured from wheat and oats and, as the fountain cannot rise higher than its source, so it is likewise impossible for these foods to contain more nutriment than exists in the products from which they are manufactured. They have a place in the human dietary and properly prepared, in this place, they are valuable and legitimate foods. It is, however manifestly out of place to attempt to make them constitute the entire meal, and persons suffering from faulty digestion will do well to rely for guidance on sources other than the outside of the breakfast food package.

FIBER IN BREAKFAST FOODS.

It is well to note in connection with the cereal products mentioned in this bulletin that they contain considerable fiber—much more than is found in white wheat bread and patent flour. As explained above† this means that pound for pound the nutrients in the breakfast foods are less digestible than are the nutrients in the patent flour and white bread.‡ Not only this but what is digested must be at a greater cost to the system. On the other hand this very fiber that contributes to the lower degree of digestibility may be the means of making it more wholesome because it gives buoyancy and bulk to the meal and aids the digestive organs in their peristaltic actions.

Some of these foods are exceedingly palatable and we must recognize that such points as these have a very important bearing on the selection of human food; and man, for some time to come, will undoubtedly be willing to pay considerably beyond the intrinsic value of the goods if they are but pleasing to the eye and taste. He can be put on the engine basis so far as the fuel supply for his body is concerned, but beyond this are his physiological functions to maintain and his aesthetic nature to please.

---

*Adapted from an advertisement concerning Grape Nuts.

†See § note page 10.

‡Dr. Gudeman in some artificial digestion experiments conducted with prepared foods vs. raw foods secured results which he expresses in the following language: "It was found that the raw cereals, if sufficiently cooked, were as quickly digested as the best malted cereals, more quickly than the prepared cereals, and a large majority of the so called malted cereals."—Journal American Chemical Society, March, 1904.

TABLE I.

Lab. No.	Trade name.	Manufactured by	Place of manufacture.	Weight, lbs.*	Price per package.†
101—B	Granola	Battle Creek Sanitarium Food Co	Battle Creek	1.00	$0 15
102—B	Granose Flakes	Battle Creek Sanitarium Food Co	Battle Creek	0.83	15
103—B	Zwieback	Battle Creek Sanitarium Food Co	Battle Creek	1.25	
104—B	Granose Biscuit	Battle Creek Sanitarium Food Co	Battle Creek	0.83	15
105—B	Toasted Wheat Flakes	Battle Creek Sanitarium Food Co	Battle Creek	1.18	15
106—B	Cream Shortened Sticks	Battle Creek Sanitarium Health Food Co	Battle Creek	1.30	15
107—B	Grape Nuts	Postum Cereal Co., ltd	Battle Creek	1.12	15
108—B	Malt-Ola	Lansing Pure Food Co., ltd	Lansing	1.20	15
109—B	Grape Sugar Flakes	Com. Travelers & Farmers National Food Co	Battle Creek	1.16	15
110—B	Neutrita	Manfrs. & Retailers' Assn., ltd	Battle Creek	1.16	15
111—B	Malt-Wheat Biscuit	Lambert Good Food Co., ltd	Battle Creek	1.16	15
112—B	Malted Zwieback	Lambert Good Food Co., ltd	Battle Creek	1.00	15
113—B	Korn Krisp	The Korn Krisp Co., ltd	Battle Creek	1.16	15
114—B	Malta-Vita	Malta-Vita Pure Food Co	Battle Creek	1.30	15
115—B	Force	The Force Food Co	Buffalo	0.95	15
116—B	Toasted Corn Flakes	Sanitas Nut Food Co., ltd	Battle Creek	1.16	15
117—B	Cera Nut Flakes	National Pure Food Co., ltd	Grand Rapids	1.00	15
118—B	Bourdeau Flakes	Bourdeau Food Co., ltd	Battle Creek	1.10	15
119—B	Malt-Too Flakes	Malt-Too Flake Food Co	Battle Creek	1.40	15
120—B	Norka Malted Oats	Malted Food Co., ltd	Battle Creek	1.30	15
121—B	F. S. Rolled Avena	The American Cereal Co	Chicago	2.00	15
122—B	Cook's Flaked Rice	American Rice Food Mfg. Co	Matawan, N. J	1.00	15
123—B	Ralston's Health Breakfast Food	Robinson-Danforth Milling Co	St. Louis	2.00	15
124—B	Ralston's Hominy Grits	Robinson-Danforth Milling Co	St. Louis	2.00	10
125—B	Wheatlet	The Franklin Mills Co	Lockport, N. Y	2.00	15
126—B	Pillsbury's Vitos	Pillsbury-Washburn Co	Minneapolis	2.10	15
127—B	Cream of Wheat	Cream of Wheat Co	Minneapolis	2.00	15
128—B	Mother's Crushed Oats	Gt. Western Cereal Co	Chicago	2.00	10
129—B	Pettijohn's Breakfast Food	American Cereal Co	Chicago	1.90	13
130—B	Quaker Rolled White Oats	American Cereal Co	Chicago	2.00	10
131—B	American Flaked Oat Groats	American Cereal Co	Chicago	2.00	10
132—B	Pillsbury's Flaked Oat Food	Pillsbury-Washburn Co	Minneapolis	2.00	15
133—B	Snow Flakes	Deeming-Palmer Milling Co	San Francisco	2.00	15
134—B	Shredded Whole Wheat	The Natural Food Co	Niagara Falls	1.00	11
135—B	Eat-A-Biscuit	Grocers Specialty Mfg. Co	Battle Creek	1.30	15
136—B	Gum Gluten Ground	Pure Gluten Food Co	New York		
137—B	Gum Gluten Breakfast Food	Pure Gluten Food Co	New York		
138—B	Gluten—20%	Sanitarium Food Co	Battle Creek	1.25	20
139—B	Vigor-O	Vigor-O Health Food Co	Owosso	1.00	15
140—B	Tryabita Food	Tryabita Food Co., ltd	Battle Creek	1.00	15
395—B	Voigt Cream Flakes	Voigt Cereal Food Co., ltd	Grand Rapids	1.25	15
396—B	Mapl Flakes	Hygienic Food Co	Battle Creek	1.00	15
397—B	Oxford Flakes	Oxford Pure Food Co	Detriot	0.62	15
398—B	Flak-Ota	Battle Creek Flaked Food Co., ltd	Battle Creek	1.25	15
399—B	Crescent Wheat Flakes	Lake Odessa Malted Cereal Co., ltd	Lake Odessa	1.00	15
400—B	Wheate-Nut	Wheelock Milling & Cereal Co	Battle Creek	1.25	15
403—B	Vigor	The H-O-Co	Buffalo	1.00	15
404—B	Excelo	The National Cereal Co., ltd	Battle Creek	1.00	15

*Includes weight of package.
†Large amounts usually at reduced rates.

TABLE II.

Laboratory No.	Trade name.	% Moisture.	% Crude protein.	% Carbohydrates.	% Fats.	% Crude fiber.	% Ash.	Full value in calories per gram.
101—B	Granola	9.97	13.42	72.94	0.40	1.43	1.84	3952.4
102—B	Granose Flakes	11.08	11.49	71.83	0.49	2.29	2.82	3836.5
103—B	Zwieback	10.64	14.31	68.87	0.49	4.21	1.48	3964.2
104—B	Granose Biscuit	9.74	12.11	71.65	0.69	2.81	3.03	3906.0
105—B	Toasted Wheat Flakes	10.05	9.48	76.24	1.47	1.85	2.36	3975.8
106—B	Cream Shortened Sticks	8.35	8.65	76.54	0.32	3.83	1.31	3974.7
107—B	Grape-Nuts	8.00	12.73	73,78	1.57	2.02	1.90	4080.7
108—B	Malt-Ola	7.10	13.08	75.07	1.33	0.62	2.80	4096.7
109—B	Grape-Sugar Flakes	8.13	10.27	75.87	1.76	2.28	1.69	4051.9
110—B	Neutrita	9.07	12.99	71.26	2.06	1.77	2.85	4025.2
111—B	Malt-Wheat Biscuit	8.45	12.73	76.23	0.41	0.44	1.74	4009.3
112—B	Malted Zwieback	9.22	14.66	71.50	1.62	1.30	1.70	4073.2
113—B	Korn Krisp	8.00	10.27	76.52	1.86	0.88	2.47	4029.7
114—B	Malta-Vita	8.93	11.84	73.19	1.55	1.82	2.67	3993.1
115—B	Force	10.44	11.32	71.87	1.50	1.82	3.05	3902.4
116—B	Toasted Corn Flakes	9.63	9.21	78.31	0.54	0.57	1.74	3906.6
117—B	Cera Nut Flakes	7.80	13.16	73.31	1.60	2.02	2.11	4089.1
118—B	Bourdeau Flakes	8.82	10.53	73.45	1.73	2.32	3.15	3964.5
119—B	Malt-Too Flakes	9.59	10.71	74.45	......	1.89	3.36	3838.2
120—B	Norka Malted Oats	9.28	15.79	64.35	4.90	2.65	3.03	4201.3
121—B	F. S. Rolled Avena	9.68	18.42	60.85	6.88	2.22	1.95	4375.6
122—B	Cook's Flaked Rice	11.65	8.78	77.66	0.40	1.22	0.29	3868.2
123—B	Ralston's Health Breakf't Food	11.07	12.55	72.11	1.72	1.35	1.20	3985.7
124—B	Ralston's Hominy Grits	11.63	8.51	77.83	0.95	0.68	0.40	3887.8
125—B	Wheatlet	12.11	14.13	69.25	2.02	1.25	1.24	3982.5
126—B	Pillsbury's Vitos	11.19	13.08	73.44	1.08	0.58	0.53	3981.0
127—B	Cream of Wheat	11.62	13.08	73.38	0.87	0.52	0.53	3956.4
128—B	Mother's Crushed Oats	9.35	18.25	62.05	7.00	1.87	1.48	4412.4
129—B	Pettijohn's Breakfast Food	10.43	12.11	71.08	2.50	2.30	1.58	4028.9
130—B	Quaker Rolled White Oats	9.40	17.55	61.56	7.20	2.40	1.89	4391.4
131—B	American Flaked Oat Groats	9.12	18.42	60.94	7.18	2.51	1.83	4419.4
132—B	Pillsbury's Flaked Oat Food	9.70	16.14	64.87	5.75	1.84	1.70	4288.8
133—B	Snow Flakes	11.20	13.60	70.21	1.65	1.81	1.53	3980.7
134—B	Shredded Whole Wheat	8.91	11.32	73.93	0.87	3.40	1.57	3996.7
135—B	Eat-A-Biscuit	7.52	9.22	75.14	1.69	3.24	2.19	4035.1
136—B	Gum Gluten Ground	10 .62	44.13	42.76	1.30	0.41	0.78	4537.7
137—B	Gum Gluten Breakfast Food	9.45	54.38	34.04	0.76	0.47	0.90	4728.5
138—B	Gluten—20%	10.53	15.75	71.71	0.58	0.39	1.04	4011.4
139—B	Vigor-O	8.97	9.90	74.39	1.74	2.23	2.77	3963.9
140—B	Tryabita Food	9.60	11.81	72.17	1.08	2.57	2.77	3936.3
395—B	Voigt Cream Flakes	9.62	9.12	74.69	1.60	2.76	2.21	3949.8
396—B	Mapl Flakes	8.61	8.78	76.92	1.47	2.20	2.02	3977.8
397—B	Oxford Flake	9.40	11.18	73.81	1.43	2.83	1.35	4011.5
398—B	Flak-Ota	8.72	15 70	66.22	4.17	1.91	3.28	4175.6
399—B	Crecsent Wheat Flakes	9.50	9.30	74.78	1.67	1.55	3.20	3909.9
400—B	Wheate-Nut	8.10	9.19	77.44	0.72	3.17	1.38	3994.8
403—B	Vigor	9.12	14.46	69.18	1.65	2.38	3.21	4012.1
404—B	Excelo	8.27	8.79	77.17	1.21	2.58	1.98	3980.6

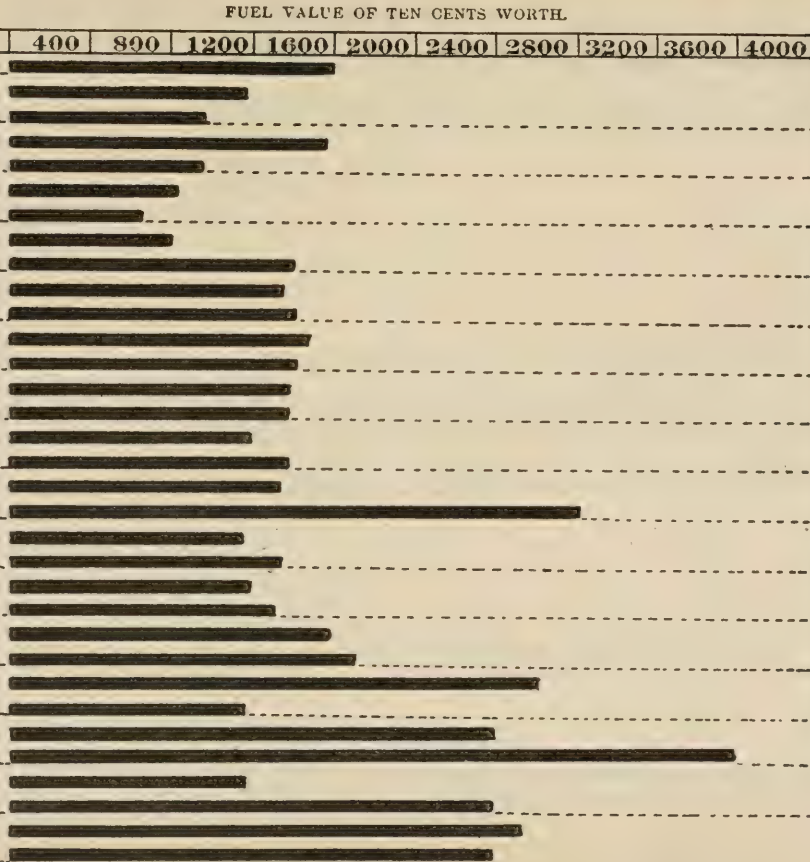
TABLE III.

Laboratory number.	Insoluble starch.	Soluble in water.						
		%Total.	%Ash.	%Not ash.	%Protein.	% Sugars	% Dextrin.	Soluble starch.
101—B...	61.32	14.16	1.76	12.40	0.78	2.75	3.42	present.
102—B...	65.93	9.09	2.42	6.67	0.77	trace	2.56	absent.
103—B...	57.08	14.08	1.46	12.62	0.83	2.93	3.70	absent.
104—B...	63.45	12.08	2.78	9.30	1.10	trace	4.12	absent.
105—B ..	51.92	27.29	2.20	25.09	0.77	10.43	6.10	absent.
106—B...	70.16	9.60	1.30	7.30	0.92	1.75	2.00	trace.
107—B...	33.15	43.76	1.86	41.90	1.27	16.48	14.76	absent.
108—B...	57.60	22.34	2.72	19.62	2.15	9.09	4.90	absent.
109—B...	62.67	15.05	1.28	13.77	0.57	1.27	4.10	absent.
110—B...	43.57	31.54	2.58	28.96	1.27	3.40	13.02	present.
111—B...	47.20	31.90	1.73	30.17	1.14	18.43	2.68	absent.
112—B...	60.32	13.65	1.55	12.10	0.92	5.05	1.48	trace.
113—B...	51.97	27.48	2.38	25.10	0.55	7.65	5.20	present.
114—B...	37.02	39.90	2.56	37.34	1.26	5.13	13.64	present.
115—B...	20.20	55.15	2.80	52.35	0.68	5.71	14.42	trace.
116—B...	70.00	10.34	1.61	8.63	0.31	trace	1.18	present.
117—B...	64.59	11.35	1.86	9.49	0.77	2.08	5.80	present.
118—B...	39.15	37.55	2.42	35.13	0.83	5.38	11.00	present.
119—B...	61.68	16.65	2.75	13.90	1.13	3.15	5.90	present.
120—B...	17.59	50.95	2.55	48.40	1.64	10.70	14.80	absent.
121—B...	52.49	10.50	0.84	9.66	1.30	trace	3.90	absent.
122—B...	68.60	10.10	0.16	9.94	0.88	trace	trace	absent.
123—B...	72.86	10.00	0.95	9.05	9.79	trace	4.36	absent.
124—B...	77.13	2.75	0.30	2.45	1.75	trace	....	absent.
125—B...	64.40	8.30	0.82	7.48	2.63	trace	5.18	absent.
126—B...	69.81	10.76	0.42	10.34	9.71	trace	1.02	trace.
127—B...	67.44	16.78	0.28	16.50	10.57	trace	1.60	absent.
128—B...	54.44	10.42	1.28	9.14	1.53	trace	5.14	absent.
129—B...	66.82	7.62	1.18	6.44	2.18	trace	3.50	absent.
130—B...	56.06	7.52	0.70	6.82	1.32	trace	5.46	absent.
131—B...	54.36	9.26	1.22	8.04.	1.46	trace	4.36	absent.
132—B...	55.55	11.80	1.30	10.50	1.18	trace	5.28	absent.
133—B...	61.35	11.56	1.06	10.50	1.64	trace	3.96	absent.
134—B...	57.69	17.90	0.74	17.16	0.92	trace	6.56	present.
135—B...	36.92	42.60	1.98	40.68	1.46	5.63	18.65	
136—B...	30.00	38.14	0.74	37.40	24.63	2.42	....	absent
137—B...	30.44	37.36	0.74	36.62	33.02	2.17	....	absent.
138—B...	57.36	16.20	0.93	15.27	0.92	1.75	4.50	present.
139—B...	61.86	16.10	2.60	13.50	0.97	trace	7.80	absent.
140—B...	61.52	14.10	2.68	11.42	0.77	trace	8.58	present.
395—B...	61.52	15.24	1.54	13.70	0.83	trace	9.50	present.
396—B...	55.32	24.96	1.94	23.02	1.42	trace	8.70	trace.
397—B...	58.86	17.26	1.32	15.94	0.99	trace	13.00	present.
398—B...	50.43	20.50	3.26	17.24	1.45	trace	11.51	absent.
399—B...	60.60	18.26	3.16	15.10	0.92	trace	5.20	present.
400—B...	38.14	41.50	1.28	40.22	0.92	9.17	16.68	present.
403—B...	62.37	13.78	3.16	10.62	3.81	trace	5.00	present.
404—B...	39.50	40.60	1.88	38.78	1.11	6.13	25.50	absent.

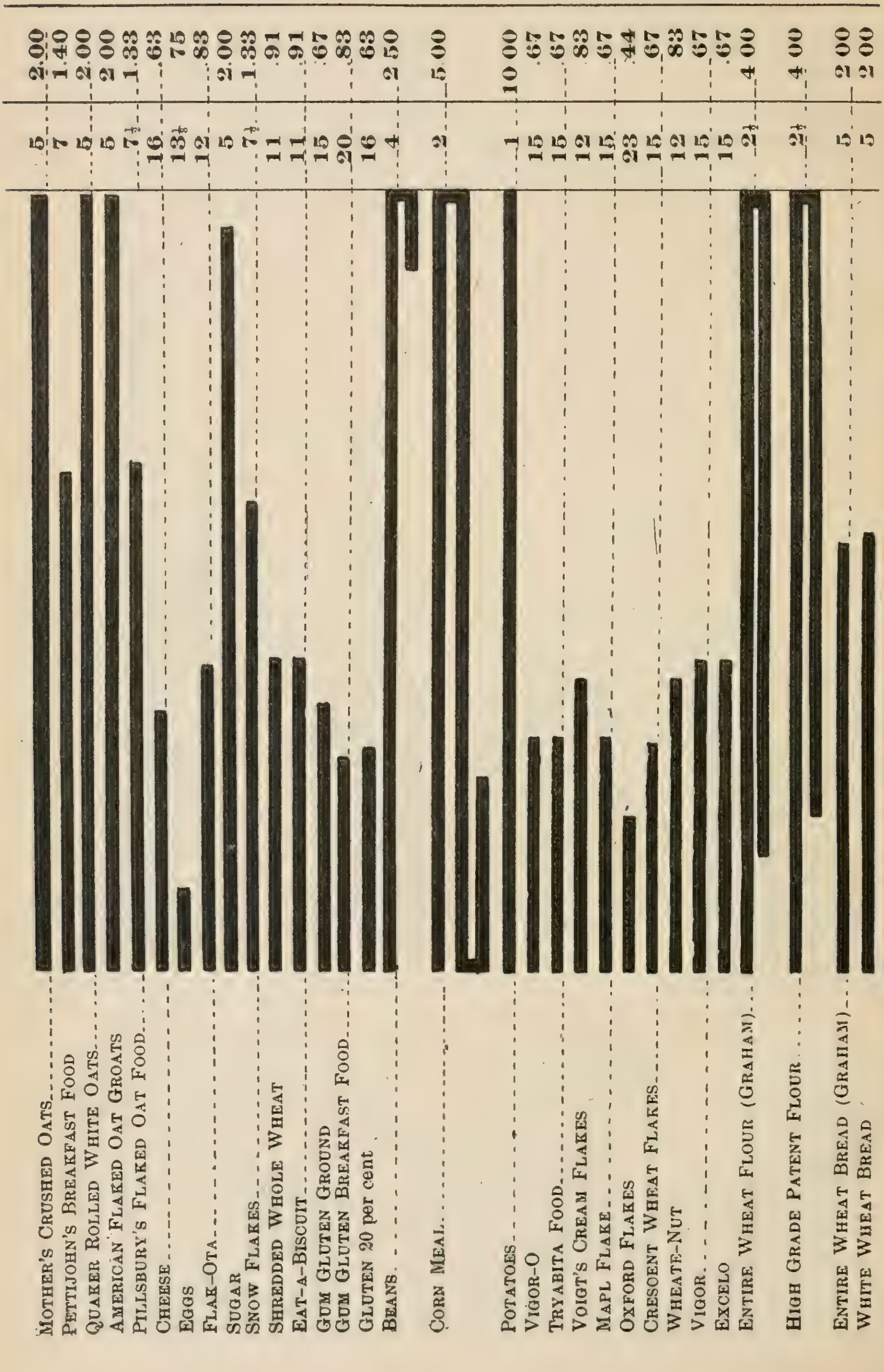
BREAKFAST FOODS COMPARED AS TO FUEL VALUES.


Cream of Wheat
Mother's Crushed Oats
Pettijohn's Breakfast Food
Quaker Rolled White Oats
American Flaked Oat Groats
Pillsbury's Flaked Oat Food
Cheese
Eggs
Olive Oil
Sugar
Snow Flakes
Shredded Whole Wheat
Eat-a-Biscuit
Gum Gluten Ground
Gum Gluten Breakfast Food
Gluten–20 per cent
Beans
Potatoes
Corn Meal
Vigor-O
Try-a-bita Food
Voigt's Cream Flakes
Mapl Flake
Oxford Flakes
Flak-Ota
Crescent Wheat Flakes
Wheate-Nut
Vigor
Excelo
Entire Wheat Flour (Graham)
High Grade Patent Flour
Entire Wheat Bread (Graham)
White Wheat Bread

TOTAL AMOUNT OF NUTRIENTS AND THEIR FUEL VALUES IN THE DIFFERENT FOODS FOR TEN CENTS.



NAME	PRICE PER LB. CENTS	10 CENTS WILL BUY POUNDS
Butter	24	42
Granola	15	67
Granose Flakes	18	56
Zwieback	12	83
Granose Biscuit	18	56
Round Steak	12	83
Sirloin Steak	18	56
Beef Rib	16	63
Toasted Wheat Flakes	13	.77
Cream Shortened Sticks	11	91
Grape Nuts	13	.77
Malt Ola	12¼	80
Grape Sugar Flakes	13	.77
Neutrita	13	77
Malt Wheat Biscuit	13	.77
Malted Zwieback	15	67
Korn Krisp	13	.77
Malta Vita	11	91
Pork–Salt	14	.71
Force	15¼	65
Toasted Corn Flakes	13	.77
Cera Nut Flakes	15	67
Bordeau Flakes	13½	.73
Malt-Too Flakes	11	91
Norka Malted Oats	11	.91
F. S. Rolled Avena	7½	1 33
Cook's Flaked Rice	15	.67
Ralston's Health Breakfast Food	7½	1.33
Ralston's Hominy Grits	5	2.00
Milk	3	3 33
Wheatlet	7½	1 33
Pillsbury's Vitos	7	1 40
Cream of Wheat	7½	1 33


Mother's Crushed Oats 5 2.00
Pettijohn's Breakfast Food 7 1.40
Quaker Rolled White Oats 5 2.00
American Flaked Oat Groats 5 2.00
Pillsbury's Flaked Oat Food 7½ 1.33
Cheese 16 .63
Eggs 13⅓ .75
Flak-Ota 12 .83
Sugar 5 2.00
Snow Flakes 7½ 1.33
Shredded Whole Wheat 11 .91
Eat-a-Biscuit 11 .91
Gum Gluten Ground 15 .67
Gum Gluten Breakfast Food 20 .83
Gluten 20 per cent 16 .63
Beans 4 2.50
Corn Meal 2 5.00
Potatoes 1 10.00
Vigor-O 15 .67
Tryabita Food 15 .67
Voigt's Cream Flakes 12 .83
Mapl Flake 15 .67
Oxford Flakes 23 .44
Crescent Wheat Flakes 15 .67
Wheate-Nut 12 .83
Vigor 15 .67
Excelo 15 .67
Entire Wheat Flour (Graham) 2½ 4.00
High Grade Patent Flour 2½ 4.00
Entire Wheat Bread (Graham) 5 2.00
White Wheat Bread 5 2.00

CONCLUSIONS.

1. The breakfast foods are legitimate and valuable foods.
2. Predigestion has been carried on in the majority of them to a limited degree only.
3. The price for which they are sold is as a rule excessive and not in keeping with their nutritive values.
4. They contain as a rule, considerable fiber which, while probably rendering them less digestible, at the same time may render them more wholesome to the average person.
5. The claims made for many of them are not warranted by the facts.
6. The claim that they are far more nutritious than the wheat and grains from which they are made is not substantiated.
7. They are palatable as a rule and pleasing to the eye.
8. The digestibility of these products as compared with highly milled foods while probably favorable to the latter, does not give due credit to the former, because of the healthful influence of the fiber and mineral matter in the breakfast foods.
9. Rolled oats or oatmeal as a source of protein and of fuel is ahead of the wheat preparations, excepting of course the special Gluten foods, which are manifestly in a different class.

APPENDIX.

The methods of analysis in the main were those adopted by the Association of Official Agricultural Chemists.

The water soluble was determined as follows:—Five grams, of the finely ground material, was weighed into a wide mouthed, rubber stoppered bottle and treated with 100 c. c. water. It was then placed in a rotating apparatus and rotated for 12 — 16 hours (over night) at the temperature of the laboratory room. The power used being a small fan motor. It was then removed, the solution and substance washed into a 250 c. c. flask made up to the mark and filtered. Aliquot portions were then taken to determine water soluble, nitrogen, dextrin and maltose (sugar).

Total Soluble.—50 c. c. filtrate corresponding to 1 gram of the original was evaporated to dryness on a steam bath in a weighed porcelain dish. This was then dried for one hour in a self regulating electric drying oven at 150° C. and weighed. Increase in weight=total solids soluble in cold water.

Ash.—The above total solids was ignited in a muffle at a low heat until all the carbon had been oxidized. This product substracted from the weight soluble gives "*Solids Not Ash.*"

Nitrogen.—50 c. c. original filtrate=1 gram food, was digested in a Kjeldahl flask as for the estimation of nitrogen in the usual way. The result multiplied by 6.25 gave the protein equivalent as in the table.*

Sugar was determined in the usual way by using Allihn's solution and estimating the reduced copper by means of a Ferric salt and Standard Potassium Permanganate Solution.

Dextrin.—50 c. c.=1 gram substance was evaporated nearly to dryness and treated with 100 c. c. 90 per cent alcohol. The precipitate dextrin was filtered on a tared filter and washed, dried and weighed.†

Soluble Starch.—The clear solution was tested qualitatively for starch in solution by means of a very dilute Iodine Solution and found, in but a few cases, in remarkably small amounts.

Insoluble Starch, represents the carbohydrates remaining after the water soluble, not ash, and protein have been removed. Direct determinations of starch were made and checked reasonably close with the figures under this head. It includes starch, small amounts of the pentose carbohydrates, etc.

*It has been quite firmly established that the proteid compounds from different sources have varying percentages of nitrogen but recognizing that these Breakfast foods are a combination of cereals in some instances have prompted us to use the original factor Nx6.25 believing we have by so doing secured a better comparison.

†The alcohol precipitate here is not pure Dextrin but may contain traces of proteids not thoroughly eliminated.

SEED TESTING FOR FARMERS.

PURITY, VITALITY.

BY B. O. LONGYEAR.

Bulletin No. 212.

"What will the harvest be?" This is a question which depends for an answer, to no small extent, upon the character of the seed sown. For no matter how fertile the soil nor how well prepared the seed bed if the seed is lacking in vitality or freedom from noxious weed seeds the highest results cannot be realized. That we shall reap as we have sown is doubtless accepted by every agriculturist, in a general way, and yet a great deal of poor seed, often containing seeds of the vilest weeds is sown every year in this State. Many of these seeds are brought from other states and from Europe and in this way some of the worst weeds from other parts of the world have become established on the farms of Michigan where they have found a congenial home and from which they can not be eradicated except with much labor and expense. The possession of some knowledge in the selection and testing of farm seeds is therefore highly important to the farmer.

It is the purpose in this bulletin to give some short, simple directions for examining and testing farm seeds, together with descriptions and figures of a few of the commonest and worst weed seeds found in such seed. Seeds may be deficient in two respects,—first in purity, second in vitality. Impurities usually consist of—

(*a*) Inert matter, such as hulls and pieces of stems, fragments of quartz or other mineral substances, insect castings, etc.

(*b*) Seeds of noxious weeds.

Inert foreign matter may be present from lack of care and thoroughness in cleaning the seed, or in some cases may have been purposely added to give more bulk and weight to the seed. In some cases quartz sand screened to the proper size has been used even in considerable amounts, as an adulterant.

The presence of weed seeds is due, of course, to the presence of weeds in the fields from which the seed was harvested and to insufficient care in cleaning. Occasionally too, seeds are adulterated by being mixed with other seeds closely resembling them. In this case the seed used as the adulterant is cheap and from some inferior kinds of plants.

Vitality of seeds is dependent upon their age, proper maturity when harvested, care in harvesting, and proper storage. In many cases, doubtless, old seeds of low vitality have been mixed with new seed, by seedsmen, in order to get rid of old stock. In any case a germination test is necessary in order to learn the vitality of a given sample.

While the foregoing remarks apply especially to seeds of clover, alfalfa, and the grasses, they are also applicable in a measure to larger seeds such as corn, beans, oats, wheat, sugar beets, etc.

PRELIMINARY EXAMINATION FOR IMPURITIES.

In making an examination of any sample of seed a person should be supplied with a few inexpensive articles all of which, with perhaps the exception of a lens, can be found in any home. The lens may be any simple pocket magnifier giving an enlargement of about five to ten diameters. Such lenses can often be purchased at jewelry stores or the local optician's for twenty-five cents, for a single lens, or forty to fifty cents for two lenses. A sheet of foolscap or other smooth white paper and a fruit knife or pocket knife complete the outfit for this work. The paper may have the edges turned up about one-fourth of an inch which will prevent the seeds from rolling off during examination.

For the examination of clover, alfalfa and similar seeds one or two tablespoon-

fuls of seed should be placed in a pile on one side of the paper, which should be laid on a table near a window. Then, holding the lens in one hand, with the knife blade draw small quantities of the seed from the edge of the pile, spread them out so that each one can be readily seen and examine them carefully through the lens. Remove all foreign material, including the weed seeds to one corner of the paper while the remaining clean seeds are pushed to one side. Continue this process until all of the sample has been thoroughly sorted. Two piles have now been formed, one consisting of clean seed, the other of impurities containing the weed seeds.

If a delicate balance were at hand it would now be possible to determine the per cent of impurities by weighing both piles and dividing the weight of the impurities by the weight of the sample before sorting. However, it is possible to

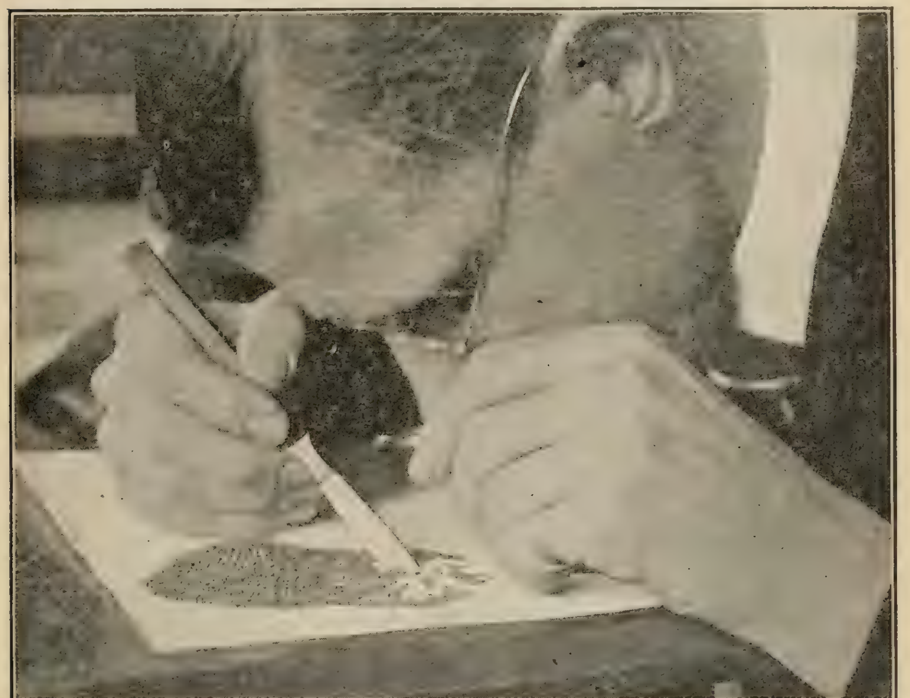


Fig. 1.—Examining clover seed for impurities and weed seeds. Place the eye close down to the lens.

gain some idea sufficient for a rough estimate by comparing the size of the two amounts. The weed seeds may be carefully saved in a small dish or vial for further examination and a sample of the clean seed counted out for a germination test.

THE GERMINATION TEST.

The value of this test will depend to a considerable extent upon the care with which it is performed. The necessary articles are a soup or dinner plate, with a somewhat smaller plate or a pane of glass for covering it, and some pieces of rather thick, clean cloth. For one or two samples of small seeds a tea saucer covered with a piece of window glass will be found ample, while the cloth, when folded, may be about three by four inches in size.

The seed for testing is first to be thoroughly mixed and one hundred seeds counted out, taking them just as they come, regardless of size or plumpness, the idea being to get as nearly as possible an average sample. A piece of the cloth

Fig 2.—Clover seed and weed seeds separated. In the sample shown the weed seeds constituted a little over one per cent of the total weight of the sample.

Fig. 3.—Testing for vitality; one hundred seeds placed on a fold of the moistened cloth.

is now dipped in water until thoroughly wet, then squeezed partly dry, after which the counted seeds are to be sprinkled over one-half of the cloth and the other half folded over upon the seeds. This is placed in the larger plate and covered with the smaller plate or the piece of glass to prevent drying out. If thin cloth is used it should be folded across two or three times in opposite directions to secure sufficient thickness.

Prepared in this way several samples may be placed in the same dish which is to be kept in a room where the temperature is comfortable for a person to live, and where the night temperature does not fall much below 50°. By using a larger number of seeds the accuracy of the test is increased, however, it is well to use some number, like one hundred, which enables one to readily estimate the per cent of vitality. If two or more lots of seeds are being tested in the same dish they should be carefully labeled to avoid mistakes. This may be done by marking a number on the cloth with ink or colored pencil, before wetting, this number to correspond with a similar number on a sheet of paper. This sheet should also have a record of the date when the seeds were placed in the tester. The seeds may be examined every twenty-four hours, the seeds which have germinated and have sprouts about one-fourth inch long being removed, counted and recorded

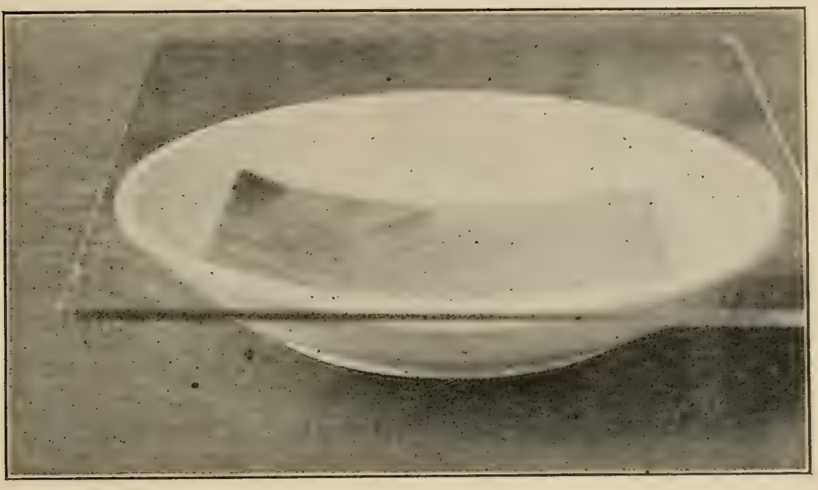


Fig. 4.—The seeds folded in the cloth and covered with a plate of glass.

on the sheet of paper, after which they are thrown away. At the end of ten days the total number of seeds which have sprouted out of a hundred, will represent the per cent of vitality of the seed. Some seeds do not sprout as quickly as others and the length of time for making the test will need to be somewhat lengthened. Thus with sugar beet seed it is customary to allow fourteen days for the completion of the test, although the number sprouted at the end of one week is estimated.

With large seeds like those of corn, peas, beans, etc., a little time may be gained by soaking in water for a few hours before placing them in the tester. The cloth should not be kept too wet or the seeds will tend to rot but if they are getting too dry, a little water may be sprinkled on the cloth. If it is desired to use the cloth again for testing seeds it should be dipped for a few minutes in boiling water to destroy any molds which may be growing on it. A soup plate of sand may also be used for testing seeds, especially large ones. In this case the seeds may be placed on the sand, which has been moistened and leveled, and covered with about one-fourth to one-half inch of sand and again moistened, or they may be laid on the level sand and covered with a moistened piece of cloth, the whole to be covered with a pane of glass.

Blotting paper and filter paper may also be used in place of cloth with very satisfactory results. This is the usual method pursued by the writer in seed testing, the paper used being a thin, gray absorbent paper much like that used by druggists for filtering liquids. This paper is first folded in several thicknesses marked and moistened, after which the seeds are sprinkled between a fold and placed in the testing plate.

EXAMINING THE WEED SEEDS.

The weed seeds which have been separated from the sample of clover, alfalfa or other seed under examination, should be carefully sorted under the lens, and identified if possible. This work requires careful attention to details, in order to be satisfactory, and the person with little or no botanical training may not expect to do much in the naming of the weed seeds which will be found. However, it will be possible for many persons to identify some of the more common weed seeds which occur in clover and alfalfa and which would be a nuisance if sown on a field not previously infested.

In order to make this naming of weed seeds as easy as possible figures from photographs are shown of a few of the most importance. These figures are enlarged to about the same extent as if they were being seen through a low power lens. Short descriptions of each kind of weed seed shown are also given and these should be carefully studied in connection with the picture.

This work of identification should be done by daylight if possible, the weed seeds being placed on a sheet of smooth white paper on a table, near a window. The lens, if without other support, should be held with one hand at the proper distance from the seeds and the eye placed close down to the lens. Then with a small bladed pocket or pen knife, or even a sliver of wood, the seeds may be sorted, those of one kind being placed together. A record should be kept of the number of seeds of each kind found in the sample and if a known part of a pound has been used the total number of weed seeds in a bushel may be estimated.

Most weed seeds can be distinguished from the seed with which they are mixed by some difference in size, shape, markings on the surface, and color. In some cases, however, the difference is so slight as to make it difficult for an inexperienced person to tell them apart. This is especially true in the case of seeds of dodder or "Love vine" which sometimes occur in western grown clover and alfalfa seed. In fact seed known to come from the west or from Europe should always be carefully examined for these weeds. Two species of dodder are to be looked for in clover and especially in alfalfa seed. These plants have the habit of growing as parasites upon the plants about them. They are very simple little vine-like plants without leaves but consisting of slender, yellowish, wiry stems which twine about the clover and alfalfa plants causing them to die down. Sometimes whole fields of alfalfa are destroyed or severely weakened by the presence of these parasitic vines, hence the presence of their seeds in clover and alfalfa seed becomes a serious menace to the growing of these forage plants.

Fortunately the seeds of the more common of these two dodders, (*Cuscuta epithymum*) are considerably smaller than those of alfalfa and red clover seed hence can be successfully removed by screening with a sieve of twenty meshes per linear inch. The seeds of the other dodder, however, (*Cuscuta arvensis*) are sometimes as large as the smaller seeds of clover and alfalfa, hence screening cannot be entirely relied upon in this case without sacrificing much seed. It is advisable, therefore, to reject any seed in which the seeds of this dodder are found.

Where dodder has been seeded with clover or alfalfa its presence will be indicated by the appearance of more or less rounded, spreading areas in which the plants are dying down, and if examined at close range the thread-like twining stems of the dodder will be found covering them. These areas can be readily seen even at some distance as they present a yellowish or light orange colored appearance. When discovered the plants within this area and for a couple of feet beyond should be cut, allowed to dry and burned, or straw may be spread on these spots and burned to destroy the dodder and prevent its forming seeds.

The Russian thistle is another pest which is being disseminated by means of Western grown seed, and while the plant may not prove to be a serious weed on loam and clay, it is gaining a foothold in the sandy portions of our state.

Another very common and vile weed found in clover and alfalfa seed is the narrow leaved plantain or "buckhorn" plantain. Its seeds are so nearly the same size as those of clover that they can be removed only with persistent recleaning. A near relative and of common occurrence is the broad-leaved plantain. In both cases the seeds can be quite readily recognized and seed containing them even in moderate amounts should be avoided.

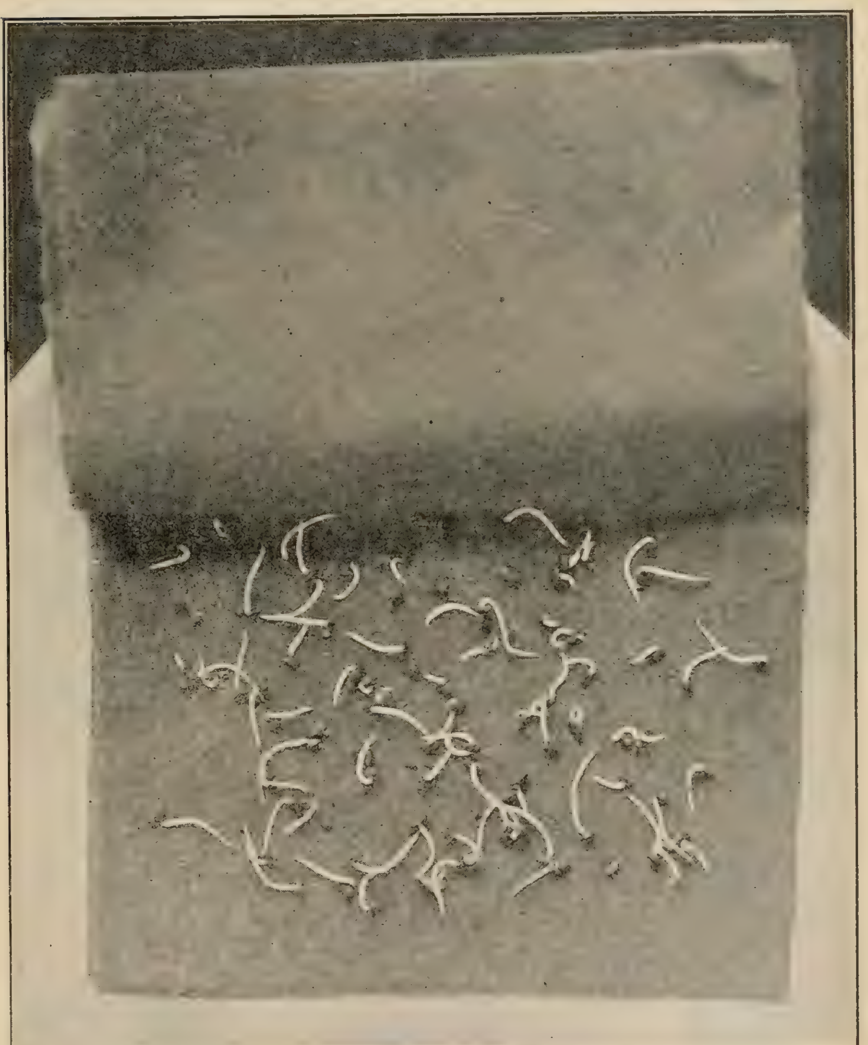


Fig. 5.—The seed germinated and ready to be counted.

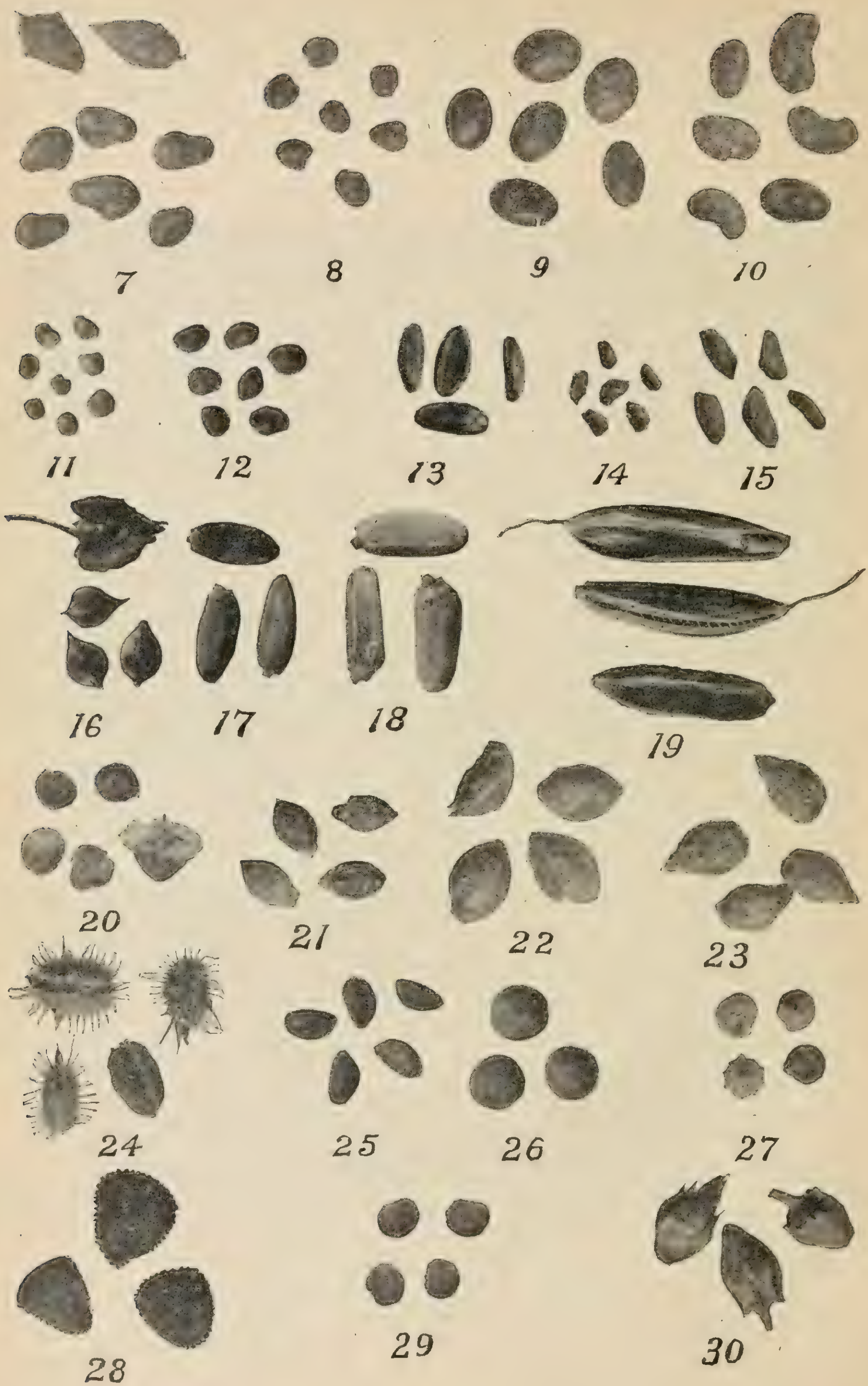

7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30

Fig. 7.—Red clover, the two uppermost enclosed in the little pod.
Fig. 8.—Alsike clover.
Fig. 9.—Crimson clover.
Fig. 10.—Alfalfa.
Fig. 11.—Clover dodder, love vine, (Cuscuta epithymum), Surface dull or minutely scurfy; color greenish gray, yellowish or brownish; often irregularly flattened, with a minute scar at one end.
Fig. 12.—Field dodder (Cuscuta arvensis) shaped much like the preceding but larger; surface dull or slightly scurfy; color yellowish, reddish or brownish. The color of these seeds so closely resembles that of alfalfa as to make their separation exceedingly difficult. The surest way to identify suspected dodder seeds is to soften them in water and carefully open them with needles mounted in handles. The embryo plant of the dodder seeds is slender and coiled up inside of a floury material, while the embryo of a clover or alfalfa seed much resembles that of a bean.
Fig. 13.—Narrow-leaved plantain, Rib grass, Buckhorn, plantain. (Plantago lanceolata). Somewhat boat-shaped, with a small scar on the grooved side; surface smooth, shining; color light brown, often with a lighter stripe along the convex side.
Fig. 14.—Broad-leaved plantain. (Plantago Major.) Shape angular, flattened; surface minutely rough and dull; color brown or brownish with a minute whitish scar on one side.
Fig. 15.—Rugel's plantain. (Plantago Rugelii.) Much like the above but somewhat larger and darker in color, being almost black with a conspicuous light scar on one side.
Fig. 16.—Curled dock. (Rumex crispus.) With the calyx removed these resemble small kernels of buckwheat, being triangular and with a smooth, polished surface; color reddish brown.
Fig. 17.—Canada thistle. (Carduus arvensis.) Shape somewhat angled lengthwise and often slightly curved with a small scar at smaller end, larger end cup-like with a small central projection; surface smooth but not polished; color light to dark brown.
Fig. 18.—Bull thistle. (Carduus lanceolatus.) These are much like the preceding but slightly larger and more often yellowish or light grayish in color.
Fig. 19.—Chess. (Bromus secalinus.) These appear slightly like small kernels of oat, but sometimes possess a short spine or awn. The chaff encloses a reddish grain which is folded lengthwise and has a dull surface.
Fig. 20.—Russian thistle. (Salsola Tragus.) These are often found enveloped with a dry calyx of a light gray color. When this is rubbed off the seed (fruit) resembles somewhat in form a chocolate drop with a concave base, in the center of which is a minute point. Surface dull, color grayish brown; embryo plant coiled in the seed.
Fig. 21.—Green foxtail. (Chaetochloa viridis.) The grains are usually partly enveloped with the thin, membranous chaff which is yellowish or greenish gray; the enclosed grain is brownish, mottled with a darker brown; surface dull except two narrow polished stripes along the edges of the flattened side.
Fig. 22.—Yellow foxtail, Pigeon Grass. (Chaetochloa glauca.) These are larger and lighter colored than the preceding, the chaff being greenish while the grain is mostly yellowish or brownish and transversely wrinkled.
Fig. 23.—Redroot, Wheat-thief. (Lithospermum arvense.) Shape somewhat conical with a convex base; surface roughened with irregular ridges and tubercles; color grayish, with the convex base nearly black.
Fig. 24.—Wild carrot. (Daucus carota.) Shape flattened with one side convex and bearing four rows of light colored spreading spines; color brownish. As found in clover seed the spines have in most cases disappeared, the convex side showing four light colored lines lengthwise.
Fig. 25.—Peppergrass. (Lepidium virginicum.) Shape much flattened, with a thin, narrow margin and a groove extending part of its length on each side; surface dull; color light brownish red.
Fig. 26.—Wild turnip. (Brassica campestris.) Shape nearly spherical; surface smooth but dull; color purplish brown or blackish with a very small light scar.
Fig. 27.—Lamb's quarters pigweed. (Chenopodium album.) These are at first enclosed in a dry closely fitting envelope which breaks away in places exposing the smooth, shiny, black seed which is flattened-convex.
Fig. 28.—Corn cockle. (Agrostemma githago.) These appear to be folded upon themselves; surface rough with points arranged in rows; color brownish black.
Fig. 29.—Evening catchfly. (Silene noctiflora.) These are much smaller than the preceding but otherwise resemble them somewhat in shape and surface; color grayish brown.
Fig. 30.—Ragweed. (Ambrosia artemisaefolio.) These are somewhat egg-shaped with a pointed projection surrounded with a crown of several tooth-like points at the large end; surface dull and slightly ridged; color yellowish, grayish or brown, often somewhat mottled.

SMALL FRUITS FOR 1904.

NOTES ON THE STRAWBERRY.

BY L. R. TAFT AND M. L. DEAN.

Bulletin No. 213.

Although the strawberry thrives under a great variety of conditions, it does best upon a moderately heavy, sandy loam or a light clay loam soil. While an abundance of moisture is required for the best results, care should be taken to have the soil fairly well drained so that water will never stand upon the land and the soil will dry out quickly in seasons when showers are frequent. For the purpose of supplying plant food as well as keeping the land uniformly moist, it should contain a considerable amount of humus, and there is no better way of fitting land for this crop than to turn under a heavy clover sod. The use of liberal amounts of stable manure is also advisable, but if it is not thoroughly decomposed it is advisable to apply it one year in advance and use the land for some hoed crop. Thirty or forty-two horse loads per acre can often be used to advantage on the average soil. As a partial substitute for the manure, good results will be obtained from 50 to 100 bushels of unleached, hardwood ashes. If there is a fair amount of humus in the soil profitable returns can often be secured from the use of commercial fertilizers as a source of plant food. Many of the mixed complete fertilizers sold by the manufacturers for the purpose, will be found very satisfactory. An equal amount of plant food, however, can generally be secured for a much smaller sum and one will be more likely to obtain what is ordered if the chemicals are obtained and mixed on the farm. By mixing from 100 to 200 pounds of nitrate of soda, 200 to 300 pounds of muriate of potash, 200 to 300 pounds of ground bone and 200 to 300 pounds of acid phosphate, an excellent fertilizer will be produced for one acre of land. After the land has been plowed and thoroughly dragged it should be rolled if the soil is loose. After rolling it would be a good plan to loosen the surface with a smoothing harrow.

The distance for setting the plants will depend a good deal upon the method of culture. If to be grown in hills, the distance may be 24 inches each way or the plants may be set 36 by 12 to 15 inches. This method, however, is only desirable for the fancy trade and with a few varieties. Ordinarily the plants are set in rows from 3½ to 4 feet apart and from 2 to 3 feet in the rows. This will make it possible to cultivate the land both ways for a number of weeks and thus save considerable hand labor. One objection to setting the plants closer than this in the rows is that they will, under favorable conditions, soon fill in the rows and if the runners are not cut off they will be turned in either direction by the cultivator and taking root, form a thick mat.

Some growers of fancy fruit advocate planting in double rows using about 32 inches in the wide spaces and 16 inches between the double rows, or there will be a double row of plants set 16 inches apart, once in 4 feet. These plants are cultivated in the ordinary way except that for working between the double rows some of the shovels are taken out so as to permit of working both sides of a row. When this method of culture is used it is quite desirable to carefully layer the plants and then cut off the surplus runners that form.

Early spring is the best time for setting out strawberry plants and strong, vigorous plants should be obtained from a plantation set the previous year. It is advisable to use the first or second plants formed upon the runners and reject the weaker plants at the end. However, the soft, succulent, overgrown plants are more likely to be checked in transplanting than the medium-sized plant of firm texture. The land can be marked out with a corn marker and the plants set with a spade or dibble. Care should be taken to have the crowns just above the surface; the roots should not be too closely matted together, but should have the soil pressed firmly about them. During the first year they should receive frequent cultivation and an occasional hoeing will be desirable. The blossom buds should be pinched out as soon as they appear and after the plants have begun to form runners the cultivation should be in but one direction. Where fancy berries are to

be produced it seems best to layer the runners so as to have the plants evenly distributed along the rows but ordinarily this is not worth while, except as it can be done with an occasional plant while hoeing.

For the average grower what is known as the narrow hedge row has many advantages. This is produced by restricting the width of the rows to about one foot, by cutting off all runners that start after this space has been covered, by means of a rolling cutter which can be attached to a cultivator.

If the plants have made a strong growth they will have filled the row by the first of September and the production of plants can be checked and the development of fruit buds aided if some crop is sown between the rows to act as a winter mulch. Barley seems especially adapted to the purpose, although oats will give good results. Under favorable conditions these crops will reach a height of one to two feet before they are killed by frost, and falling down will form a very effectual mulch. In many sections it is not necessary to provide a winter mulch for strawberries, but, where the soil is inclined to be stiff, great injury is often done to unmulched plants by breaking of the roots as a result of the freezing and thawing during the early spring. One of the best materials for a winter mulch is marsh hay, as it is free from grass and weed seeds. Straw and corn stalks also answer fairly well. If the land is to be worked the following spring a thin mulch only, should be applied. This should be scattered over the plants thick enough to hide them. In case the land will not be worked, sufficient mulch should be put on to keep down the growth of grass and weeds the following summer. Most of this should be placed between the rows with a thin covering over the plants. When spring comes if the mulch over the plants is so thick that they cannot get through, a large portion of it should be taken up and placed between the rows. Except perhaps for an occasional hoeing if weeds appear along the rows, no other care will be required until the fruit ripens. If mulched plants are to be cultivated in the spring, the mulch from several rows should be thrown together, and, after a shallow cultivation and hoeing have been given, should be replaced to keep the fruit clean.

Ordinarily no care is required to keep down insects and diseases but considerable harm is often done upon some varieties by leaf blight or rust. This is a fungus which propogates by means of spores and its spread can be checked if the plants are occasionally sprayed with Bordeaux mixture. The first application should be made after the flower stalks appear, but before the blossoms open, and a second application should be made as soon as the fruit has set, taking pains to thoroughly spray the blossom stalks as well as the foliage. In the case of varieties which are quite subject to blight such as Marshall and William Belt, it is often desirable to spray the plants as soon as the crop has been gathered if the bed is to be kept for another year.

While many prefer to replant after harvesting one crop, it is often possible to clean out an old bed at a comparatively small expense and to secure a second crop nearly equal to the first. This can be easily done by plowing away furrows on either side of the rows leaving merely a narrow strip with plants upon it. The weaker and older plants are then cut out with a hoe retaining a bunch of plants every foot or so in the row. The furrows are then leveled down with a cultivator and within two months it will look nearly equal to a new bed.

In the growing of fruit for fancy market it is very important that only such varieties as will furnish fruit of large size, regular form and good quality should be used. Care should be taken to gather only fruit that is well ripened and any berries that are soft, small or badly misshapen should be rejected. If fruit of this class can be produced, there will always be a demand for it in the large cities at a price fully double that paid for the average fruit.

Among the more desirable varieties for planting whether for home use or for market, are Excelsior, Beder Wood, Haverland, Clyde, Bubach, Senator Dunlap, Brandywine, Sample and Gandy. These have been quite generally tested for a number of years and with good care gave excellent results upon quite a variety of soils. Haverland and Clyde are rather soft for long shipment but they are both quite productive and answer very well for home use or local markets. Where berries of large size, handsome appearance and good quality are desirable, Brandywine, Sample and Dunlap will generally be satisfactory. In some sections Marshall has been grown with success for fancy market but is so badly attacked by leaf blight that it should not be grown except upon strong, moist land under the highest conditions of cultivation and even there it does not escape serious injury. Auto is a large handsome berry and seems likely to supercede Beder Wood. Cam-

eron is very promising as an early sort and Seaford and Gandy generally do well as late sorts.

Among the varieties which fruited for the first time, 1903, the list of the promising sorts is much larger than has been the case in most other years. The crop of many of the early varieties, however, was considerably injured by the frost while the plants were in blossom. Some of the kinds with tall thick foliage and with short blossom stalks which rested upon the ground showed much less injury than those whose blossoms were not protected by the foliage and in sections where the plants are subject to injury from this source, care should be taken to select the frost resisting varieties. The frequent rains which fell in June lengthened the fruiting season and the size of the berries held up well so that except in the case of a few of the early kinds, the yield was above the average, notwithstanding the loss from the frost.

The soil upon which the station plot of strawberries was grown is a moderately heavy sandy loam with a mixture of clay in the subsoil. It had been used for the growing of vegetables for several years previous to the planting of the strawberries and was brought into as good a condition as possible by the liberal use of compost and wood ashes before the plants were set out. In order to make a test of all the new kinds, it was necessary to procure them from a large number of growers and, although some were received in good condition, others showed little life, having been poorly packed. This resulted in a somewhat uneven standing and has affected, to some extent, the productiveness of several of the varieties.

NOTES ON NEW VARIETIES.

Challenge—Received from M. Crawford, Cuyahoga Falls, Ohio. Flowers perfect. The plants are low growing and give but a little protection from frost. They are vigorous, but winter-killed slightly and did not form many runners; fruit stems numerous and well filled with bloom, but nearly 50% of the blossoms were killed by frost which lowered the rating in productiveness. The berries are dark crimson, of medium size, slightly elongated, conic, or sometimes fan-shaped. The pulp is bright red, slightly soft, and of medium quality.

The variety was originated by J. R. Peck of Breckenridge, Mo. Its productiveness makes it of some value as a second early sort, although the blossoms are subject to injury by frost.

Dakota Ironclad—Eight plants were received from J. W. Millett, Bismark, North Dakota, under the name "Millett 17."

Only a few of the plants grew, but they seem to be hardy and vigorous. The foliage is rank and healthy, but the small amount of fruit developed was not sufficient to properly judge the variety.

Dewey—Received from Flansburg and Peirson, Leslie, Mich., is a seedling of the Haverland crossed with Parker Earle, originated by James Nimon, of Texas, the originator of the Parker Earle. Flowers perfect, vines vigorous, throwing out an abundance of runners and fruit stems. The leaf stalks are long and hold up the foliage so that it protects the blossoms from frost to quite an extent.

The berries are of the Haverland type, large, long necked, bright red and firm. The pulp is rather light-colored, with a pleasant acid flavor. The fruit stalks are slender, and the berries loosen from it very easily. It is an attractive berry and of some promise.

Dollar, Jr.—Received from J. T. Lovett, Little Silver, N. J. A seedling of the old variety, Dollar, introduced by O. F. Felton of New Jersey. The plants were in such poor condition when received that they made a weak growth and did not develop any fruit.

Elba—From Flansburg and Peirson, Leslie, Mich. A very hardy, strong-growing variety. Flowers perfect. The leaves are large and coarse. The fruit stems were numerous and well loaded, showing very little injury from frost. Runners abundant. The berries are regular, slightly elongated, conic, but rather small; color, bright crimson. A promising extra early variety.

Globe—Received from Mathew Crawford, Cuyahoga Falls, but originated by Eugene Sutherland, N. Y. Flowers perfect. The vines are low, hardy growers, with dark glossy foliage and well-filled fruit stems. The berries are very large, inclined to be a little irregular, oblong-conical, with a broad tip; color, bright red; pulp, light-colored, of good texture, and with a sharp but pleasant flavor. The roughness of the fruit mars the appearance somewhat, but its size makes it a promising variety.

Howell—From Flansburg and Peirson. Flowers perfect. The berries are large, elongated-conic, slightly necked, dark colored, firm and juicy. The pulp is dark crimson in color and has a rich flavor. The leaves are tall, coarse, light-green and have a wrinkled appearance.

The variety is of the Haverland type, productive and of good quality.

Iowa Queen—Received from Green's Nursery Co., Rochester, N. Y. Flowers perfect. The vines are of medium height, and dark colored; runners, scattering; productiveness, good.

The berries are large to very large, irregular, oblong-conic, bright red and thickly covered with seed. The pulp is reddish, a little soft and often hollow. The fruit is attractive but lacking in quality.

LeValley—Originated and introduced by L. H. LeValley, Ionia, Mich. It is an attractive, perfect-flowered variety and shows some points of excellence, being a very strong, vigorous grower. It is a great plant maker and forms sufficient fruit stems to make it a productive variety. The berries have a bright scarlet color, are of medium size, long-conical in shape, slightly soft, but pleasant in flavor.

Lester Lovett—Received from Flansburg and Peirson. Appears to be identical with Gandy.

Luxury—From M. Crawford, but originated by E. H. Reihl of Alton, Ill. It is said to have come from Brandywine pollenized by Williams. It has perfect flowers and in quality resembles the Brandywine. The berries are medium sized, bright crimson in color; shape, regular, conic, with a slight tendency to be a little flat at the apex. The pulp is a dark crimson, little soft. The growth of vines is weak but the quality of the fruit is excellent.

Lyon—From Flansburg and Peirson. Imperfect flowers. A seedling of Bubach, originated by L. W. Hardy, and named after the late T. T. Lyon. The vines are thrifty and vigorous, good plant makers and very productive. The berries are of medium size, regular, decidedly conic and somewhat necked. Color, bright red; flavor, pleasant. They have a tendency to overbear which is liable to make them rather small.

Miller—Also from Flansburg and Peirson. Perfect flowers. It seems to lack hardiness and vigor. The vines are low growing, and showed a tendency to rust. The leaves are broad, medium to dark green; runners scattering; fruit stems few, long and stout. Berries of medium size, regular, round conic, light-colored, and of fair quality. It is of the Beder Wood type.

Minute Man—Another variety received from Flansburg and Peirson; was originated by Geo. F. Wheeler of Massachusetts. Flowers imperfect. The vines are vigorous; fruit stems numerous and well filled. The berries are very attractive; size, large; color, bright scarlet; shape, regular, conic; pulp, firm, dark red; flavor, excellent. The seeds are numerous, bright colored, and deeply set, giving the berries an attractive appearance which, with its quality, makes it a very promising variety.

Palmer—Received from Myer and Son, Bridgeville, Delaware. Flowers perfect. Introduced by T. C. Kevitt of New Jersey. It is an early variety. The vines are low growing, thus giving the blossoms very little protection from frost. They were badly injured this year. Foliage light green. The plants made a rather weak growth, but are quite productive. Berries small, dark colored, with a regular conical form and a sharp acid flavor.

Rochester—From Green's Nursery Co., Rochester, N. Y. Flowers perfect. The vines are vigorous, but seemed to lack hardiness. The leaves are low and thick and have a dark glossy green color. It is a great plant producer and very productive, although many blossoms were frosted. The fruit is rather small, but has a good color and a firm pulp, making it desirable for canning purposes. The shape is conical, slightly irregular; flavor, sharp acid.

Samson—Received from C. W. Graham, Afton, N. Y. Originated by P. J. Miller, N. Y. Flowers perfect.

Smith—Received from J. T. Lovett, Little Silver, N. J. Flowers perfect. This is a quick maturing variety, but the fruit is small, light-colored and rather soft. It has a regular conical form and a pleasant acid flavor. The vines are hardy, with numerous runners. The foliage is dense and upright. Fruit stems abundant and well loaded. It is only valuable for its earliness, as the general characteristics of the berries are undesirable.

Springdale Beauty—From Flansburg and Peirson. Flowers perfect. Originated in Arkansas and is supposed to be a cross between Crescent and Wilson. The vines are thrifty, of the Crescent type and form many runners and fruit stems.

The berries are of medium size; shape, oblong-conic, slightly flattened; color, bright red; pulp, reddish, rather soft and of a sharp acid flavor. It is early and very productive, but the berries are too small to be attractive. They have a light color and are desirable for canning purposes.

Sutherland—Received from M. Crawford. It was selected from Bubach seedlings by Eugene Sutherland. Flowers imperfect. The vines are vigorous and hardy, of medium height, dense, and have a dark, glossy green color. The berries have a light crimson color and strongly resemble its parent; pulp, very light, rather soft, and juicy. They are a little smaller than Bubach and are rather more irregular, but have a pleasant flavor. Very productive and have other very desirable traits.

Sunrise (Youngs)—From C. W. Graham, Afton, N. Y. Flowers perfect. A very early and productive variety, ripening about the same season as Excelsior. The vines are all that could be desired in growth. The leaves are stout, dense and have a bright green, healthy color. Berries are a little small, regular, light colored, slightly soft, and have a sharp acid flavor. It has no special value except for its earliness, although it might be used as a fertilizer for other varieties of better quality.

Tama Jim—Originated in Iowa. Received from Myer and Son. Flowers perfect. This is one of the most promising among the mid-season varieties. The vines are strong and vigorous; foliage, tall, dense and of a dark glossy green color. It is a prolific plant maker and the numerous fruit stems indicate productiveness. The berries are large to very large, bright and red and firm for so large a berry. The form is oblong-conic, with a slight tendency to irregularity, but the size makes them quite attractive. The flavor is very pleasant.

Trimble—From A. L. Wood. Flowers imperfect. The vines seem to lack in vigor as well as in hardiness, being small, with few runners and fruit stems. The berries are small, regular, conical and of a bright red color. The seeds are small and thickly set over the surface. It fails to show any points of value.

Yant—Received from J. T. Lovett. It was originated by John Yant, and introduced in 1901 by H. M. Martin of Stark Co., Ohio. A dark red, medium to large, regular, conical shaped berry of the Brandywine type. They are slightly necked and of good quality. A promising variety.

FOREIGN VARIETIES.

For the purpose of comparing English and American varieties, arrangements were made to exchange with Laxton Bros., Bedford, England, some of our leading new sorts for an equal number of their better varieties. In May, 1903, twenty varieties were received from them. The plants were somewhat delayed in transit and many failed to grow but, by carefully plotting them, a few specimens of all varieties were saved. Some of the different types are very interesting, and their growth will be carefully watched and noted.

One point desired is to get varieties by which our fruiting season can be extended. Some of the English varieties are noted for giving two crops in one season. This will be carefully watched, but the climate conditions are so different that little can be expected along this line.

NOTES ON VARIETIES REPORTED IN 1902.

Auto was one of the most attractive among last year's varieties. The berries are extremely large, very attractive and of good quality. In vigor and productiveness it is remarkably good, and of the same season as Bedder Wood.

Belle of La Crosse is a good yielder for an early variety, but the berries are a little under size.

Cameron Early again showed points of value as an extra early sort, but it was badly injured by the frost.

Commander for a mid-season variety, is very attractive and seems to be worthy of a place with some of the dark-colored, standard sorts.

Corsican ranked about the same as last year; while a little shy of fruit the berries are attractive and desirable.

Double Cropper from Childs and Brandt appear identical. For hill culture it is worthy of trial as one of the most desirable of its class.

Duffs failed to show any points of merit.

Everbearer and Giant received from Jno. A. Salzer, La Crosse, Wis., are good berries for their season, but did not appear to be especially valuable.

Hawaii is an extremely productive and vigorous variety and for a medium early sort to be grown under ordinary care it has some value.

Hero failed to show productiveness sufficient to make it worthy of planting.

Howard No. 2 has the same failing.

Jersey Market for some soils would be a valuable medium late variety.

Late Mastodon is a very late variety, but seems to fail to properly fertilize, and developed many imperfect fruits.

Leo has little to commend it, but Marie is a dark-colored berry of considerable promise.

Manokin is a good canning variety, having a firm acid pulp.

Monitor promises to be of some value as a late variety.

Perfection and Ponderosa are not especially desirable. The latter is early and yields well, but is not equal to many of our standard varieties.

Rip Snorter proves to be a heavy bearer and a wonderful grower, but is easily frosted. With ordinary culture it is deserving of a place.

Simons Early and Table Queen are of little value.

Uncle Jim and Uncle Sam are two medium-late varieties of considerable value.

BLACKBERRIES.

The season was such that the crop was heavier than for several years and the berries were of extra fine quality.

A few varieties fruited for the first time this year, but it is difficult to base any real value on them for general use until they have been given further trial.

NOTES ON NEW VARIETIES.

Howard—Received from Edgar Howard, Stevensville, Mich. Twelve plants were received in 1901. They made a good growth of medium-sized canes and produced a small amount of fruit. The berries are good color, of medium size, slightly elongated, pulpy and have a pleasant flavor.

Mer Sereau—Received from H. S. Wiley, Cayuga, N. Y. Plants put out in 1901 fruited this season. They seem to be vigorous growers, but lack in hardiness. The berries are large, well-developed and free from the hard core found in many varieties. The pulp is thick and has a sharp pleasant flavor.

Nearly all of the older varieties gave a very heavy crop of fruit. The plants were but little injured by the winter and the frequent rains aided them in developing a fine crop of fruit.

Allen—Under favorable conditions is a productive variety. The berries are long, thick and of fairly good quality.

Clark—Ripened August 16th and showed a long fruiting season. The canes are strong, healthy growers and very productive; berries large and elongated; core, small; pulp, thick and juicy, with a rich pleasant flavor.

Fruitland—Began ripening August 12th. The canes are rank, upright growers and contained a good setting of fruit. The berries are large, nearly round, have a small core, and a rich pleasant flavor.

Hesse—Has seemed to be rather tender. The canes are large and have a spreading habit, branching close to the ground, which would make them difficult to handle in a plantation, unless staked. The berries are attractive and of fine quality.

Rathbun—Is not sufficiently hardy to thrive without winter protection. The plants made a medium growth, and set a good crop of fruit. The berries, which are of large size and excellent quality, began ripening August 14th.

Reyner—Commenced to ripen August 20th. The berries are of medium size, round, of a bright, glossy, black color and had a pleasant mild flavor, but with a large, hard core. They were rather small toward the end of the season. The canes were stout and upright.

Sanford—The canes are of medium growth and as they were very productive, the fruit was small and seedy.

Sugar Plum—Is more of a novelty than a berry of any value. It was received from John Lewis Childs, Floral Park, New York. The bushes resemble red rasp-

berries, but the fruit is of medium size, irregular, round in shape; has a dull, dark red color, and a flavor that is astringent and undesirable.

It has no value as a blackberry and should not be planted near desirable sorts as the effect of cross pollenization is very marked.

CHERRIES.

The trees blossomed very full, but the late frosts nearly ruined the crop. The sweet cherries were all killed, but of the Morello sorts Early Richmond, Louis Phillipe, Montmorency and Wragg matured a small amount of fruit.

Early Richmond—A standard early variety; is very hardy and productive.

Montmorency—A large, red cherry; is excellent for canning purposes. The trees are compact strong growers and with good care bear annual crops.

Wragg—A dark red Russian variety; is very productive and has a dark juice, that unless thoroughly ripened is decidedly acid. The fruit is very attractive and hangs on the trees a long time.

COVER CROP EXPERIMENT.

In 1902 a cover crop experiment was begun at the College, to test the relative value of several varieties of cow peas, sand vetch, velvet beans, Canada peas, crimson, mammoth and the June clovers, oats, rye, buckwheat, rape and flat turnips.

The orchard which was selected for the test contained apple trees which range from ten to fourteen years old. The land was thoroughly cultivated during the first part of the season, keeping it clean and covered with a dust mulch. On August 4th, it was laid off in plots of one-quarter acre and sown to the crops mentioned above. The cow peas were sown broadcast on one section and in drills on another. The other crops were all sown broadcast, the amount of seed used ranging from four to sixteen quarts of the coarser seed, while two quarts of the clover seed, one-half pound of the flat turnip and one pound of rape were used.

The plots were divided and one-half of each was sown with oats to test their value as a nurse crop. The seeds all made a good start, but the season was cold and wet, and the cow peas and velvet beans made but a short growth and were killed by the first frost. They should be sown in June and require a warm season. The sand vetch made a rapid growth and, at the time that winter set in, the ground was nicely covered.

There was very little difference in the growth of the clovers. The rape and flat turnips covered the ground quite nicely when winter came. Barley was used with the Canada peas as a nurse crop and was of as much value or greater value than the oats. The sand vetch started early and made a rank growth. At the time of plowing, about the first of May, many of the vines were 5 feet in length and formed such a matted mass that it was impossible to plow it until it had been thoroughly worked and cut up with a disc harrow. It furnished a large amount of vegetable matter to be worked into the soil, but in a dry season it might seriously affect the growth of the trees by robbing them of food and water. However, if judiciously used, it is of considerable value as a cover crop. The rape and flat turnips started in the spring and developed a vigorous growth of seed stalks, but, although they were of some value in holding the snow and furnished some humus, they are of doubtful value as cover crops.

The clovers started early in the spring and, as soon as the crimson clover was in blossom, were plowed under. There was very little difference in the growth of the two, although the Crimson clover matured earlier than the Mammoth.

Wherever the oats and barley were sown, the difference in the amount of moisture in the soil was noticeable during a large part of the season, and at the time of plowing, the soil was much more friable and worked better. They both made a rank growth and, freezing down during the winter, formed a mulch that was of

much benefit to the soil. Of the two, barley makes the stronger growth and is to be preferred.

The orchard was worked and kept clean until August 3rd, 1903, when a second test was started in which the sand vetch, barley, oats, cow peas, field peas, and Mammoth and Crimson clovers were included. They all made a good start, but the season was so wet and cold that the cow peas did not make as good a growth as the previous year, which seems to strengthen the fact that they have no value as a cover crop in Michigan orchards when sown as late as August 1st. The other crops made a good growth when winter set in, the ground was well covered.

TOMATOES AND POTATOES.

TOMATOES.

BY L. R. TAFT AND M. L. DEAN.

Bulletin No. 214.

The wet weather during the past season made the variety test of tomatoes rather unsatisfactory. The vines made an abnormal growth and set only a small amount of fruit, most of which failed to mature, while much of the fruit that matured was soft and of poor quality. The soil upon which the test was made had been used several years for the growing of vegetables, but last season was seeded to Crimson clover and heavily manured with well-rotted compost. The ground was plowed early in the spring, rolled and worked frequently to conserve the moisture, and get the soil in the best possible mechanical condition. The location was well under-drained but the excessive rains kept it in such condition that good results were impossible.

For several years there has been much inquiry as to the relative earliness of the fruit from transplanted plants, and those sown in the field. To determine this, several varieties, both early and late, were selected and on April 13th seed was sown for one lot in small boxes in the greenhouse. As soon as the seedlings were of the proper size, which is about two inches in height, they were picked out into flats and given a space two inches square. June 13th the plants were transplanted into the field in rows six feet apart, with four feet in the row. The weather was favorable and the plants showed no check from the transplanting. At the same time seed was sown in hills; on June 20th the seedlings began to show through the ground and on July 14th were thinned to one plant in a hill, leaving the strongest and most thrifty plant. The seedlings made a very rapid growth and grew faster and more stocky than did those transplanted. There was but little difference in the maturing of the tomatoes but the exact difference it would be hard to determine, because so many of the varieties failed to mature the crop.

The advantage of staking tomatoes was very clearly demonstrated; as the tomatoes can be planted much closer, the fruit will be of better quality, and in excessively wet years it is possible to ripen a good crop of fruit when if planted in the ordinary manner it might not mature at all.

NOTES ON VARIETIES.

Atlantic Prize—One of the standard early varieties of the Ruby class. It is bright red in color, a little rough but very productive.

Beauty—One of the most popular of its class. It is of medium size and has a purple tinge. The fruit grows in clusters and maintains its size during the entire fruit season. It is very solid and popular as a shipping sort.

Belmont—A desirable early variety. It is of the Trophy type, smooth, and of good quality; color, bright red.

Bird—One of the earliest varieties grown, but is rather small to be popular as

a commercial sort. The quality is good and it should be included in every home garden as an extra early sort.

Bolgiano's Best—A bright red tomato of much value. The quality and texture is of the best and it ranks among the better sorts.

Brandywine—A medium-sized tomato of bright red color and pleasant flavor; usually smooth; follows the early varieties. One of the best of its season.

Bright and Early—From James Vick's Sons, Rochester, New York. An early variety of good texture and quality, but it is small and often rough.

Brinton's Best—A mid-season variety; of medium size, red, good quality, firm, solid, but is a little rough, although classed among the smooth sorts.

Buckeye State—One of the best varieties for the main crop. In color it resembles Beauty, although darker. Of large size, firm, solid, and a good shipper; sometimes a little rough.

Burbank Preserving—A small, bright red tomato growing in clusters. Of no value except for preserving purposes.

Cardinal—Plants productive. Fruit smooth and of good quality

Challenge—From F. B. Mills, Rose Hill, New York. Quite productive. The fruit is usually smooth and of a bright red color, but is rather soft.

Climax—Received from Burpee. Very productive, attractive, and of excellent quality. Color, purple.

Combination—Large scarlet, solid, smooth and of value for forcing as well as for field culture.

Crimson Cushion—Bright crimson in color and very productive. The quality and texture is good. It is very smooth and ripens evenly.

Crimson Robe—From John A. Salzer and Co., La Crosse, Wisconsin. Of some value, although not superior to many other sorts.

Crimson Whirlwind—From John A. Salzer and Co. Inclined to be rough. A strong, vigorous grower, but the plants did not mature much fruit.

Democrat—An old variety of considerable value. Bright rose red in color and of good size and quality.

Dominion Day—A mid-season sort of good quality. Of medium size, bright red, usually smooth and of considerable value for forcing and market purposes.

Duke of York—From J. Bolgiano and Sons, Baltimore, Maryland. Vines spreading and quite productive. Fruit, dark red with a purple tinge; a little rough at the stem but generally smooth. Very large and of fine flavor.

Dwarf Aristocrat—From J. C. Vaughan, Chicago, Ill. Resembles the Dwarf Champion in growth and quality, but is red in color.

Dwarf Scarlet Champion—From J. C. Vaughan. A selected strain of Dwarf Champion. The plants are productive and the fruit is of good quality and handsome. A valuable market sort.

Early Tree—A dwarf variety. The fruits are small, a little rough, of a bright red color and of good quality.

Earliana—(Sparks)—From Joseph Harris Seed Company, Moreton Farm, N. Y. One of the best early varieties. Color, deep red. Of medium size, solid, of fine flavor and very productive. Among the best early varieties.

Eclipse—From Weeber and Don, New York, N. Y. A strong grower and very productive. The fruit is very smooth, bright red in color and of excellent quality. Promising as a commercial sort.

Essex—From R. and J. Farquhar and Co., Boston, Mass. An early variety with smooth, bright red fruits.

Eureka—From H. L. Holmes, Harrisburg, Pa. An early variety of good quality.

Everbearing Giant—From the Great Northern Seed Co., Minneapolis, Minn. A strong growing sort. Quite productive, but did not ripen evenly. Fruit bright red.

Excelsior—From Wm. Henry Maule, Philadelphia, Pa. A very smooth, productive variety with purple fruit. A mid-season sort which ranks among the better sorts.

Faultless—From R. and J. Farquhar. Is a good grower, productive, and attractive.

Favorite—Fruit large, dark red tending to purple, smooth, firm and solid, and of excellent flavor.

Freedom—An early variety; inclined to be a little rough.

Ignotum—Among the best for the main crop. Very productive, and excellent for canning or shipping purposes. Color bright red, regular, and smooth.

Ignotum, Potato-Leaf—Very similar to Ignotum, except that the vines are of the potato-leaf type and the color is purple.

Illinois—From Great Northern Seed Co. An early variety of much promise.

Jewel—From Burpee and Co. A new, bright red variety which resembles the Stone, but is much earlier. Well worthy of trial.

Large and Early—From W. Atlee Burpee and Co. Plants quite productive and among the first to ripen. Fruit large, purple and rather soft.

Long Island—A very productive variety of some value.

Long Keeper—Very productive. Fruits bright red, and of good quality, firm and solid. For shipping purposes it has some value owing to its firm flesh.

Magnus—A large growing, mid-season variety with bright red, handsome fruits

Matchless—From Burpee and Co. A bright red, large, smooth variety.

Marvel—From Henry A. Dreer, Philadelphia, Pa Very productive. The tomatoes are of medium size and ripen evenly. Color bright red, very attractive and of excellent quality.

Mayflower—From John A. Salzer Seed Co. Of some value for forcing purposes Bright red and of good quality.

Melrose—Extra early, purple, smooth and of good quality, but lacking in productiveness.

Minnesota—From Northrup, King and Co., Minneapolis Minn. An early variety similar to Earliana but of poor quality.

Michigan—Is one of the most desirable mid-season varieties and with the Earliana and one late sort makes a complete list for garden purposes. The fruit is bright red, attractive, firm, and solid.

New Glory—From J Bolgiano and Sons. A smooth bright red variety.

New Imperial—A productive variety of considerable value. Matures very early smooth, solid and bright red changing to purple.

Niagara—From John A. Bruce and Co., Hamilton, Canada. Plants very productive. Fruits of medium size, bright red, very smooth, firm and of good quality. One of the most promising of the new sorts.

Noble—A smooth, bright red variety of good quality.

Northern Light—From the Great Northern Seed Co. One of the early-maturing varieties of considerable promise. Of medium size, bright red, smooth, and productive.

Noltes Earliest—From D. M. Ferry and Co., Detroit. A comparatively new early variety of much promise, owing to its productiveness, quality and attractive appearance. The fruit ripens evenly and ships and keeps well. It is worthy of a place among the early varieties.

Peachblow—From R. and J. Farquhar and Co. Small, purple and usually smooth Very productive, but rather small as a commercial variety.

Potomac—From Harris Seed Co. A productive and popular variety. The fruit ripens evenly and is generally smooth; bright red in color and of good quality.

Ponderosa—One of the largest varieties grown. In some seasons it fails to ripen properly and is often rough. The vines are very vigorous and productive.

Plentiful—From R. and J. Farquhar and Co. Productive but rather small and often rough.

President Cleveland—From R. and J. Farquhar and Co. The vines are strong and productive. Fruit a little rough and late in ripening.

Prizewinner—A medium to large, productive variety, with bright red fruit of a pleasant flavor and attractive appearance.

Queen—Very similar to Prizewinner, except that it is a little smaller and smoother.

Quicksure—From Burpee and Co. A very large, extra early variety, but often rough, and soft.

Quarter Century—From J. M. Thorburn and Co., New York, N. Y. Among the best of the dwarf varieties. Fruits smooth, solid, of good size and of a handsome bright scarlet color.

Rockford—From R. and J. Farquhar. A strong, vigorous growing and very productive variety. The fruits are smooth, medium sized, dark scarlet in color, firm and of excellent flavor. Of considerable value as a forcing sort.

Redfield Beauty—From J. Bolgiano and Sons. Similar to Beauty and probably a selected strain.

Ruby—From Northrup, King and Co. A very early, bright scarlet variety. It is usually quite productive, large and of good quality. One of the best varieties of its class.

South Jersey—From D. Landreth and Sons, Philadelphia, Pa. An upright, vigorous growing plant, but it requires too long a season for this climate.

Stone—From the Livingston Seed Co., Columbus, Ohio. One of the best of its class and largely grown for canning purposes. The fruit is large, bright red and very firm and smooth and of excellent flavor.

Success—From Burpee and Co. A very productive variety that is worthy of a place among the standard sorts. The plants are strong and vigorous, and the fruits are large, smooth, firm and have attractive bright scarlet color.

Table Queen—From Henry A. Dreer and Co. A bright red variety, smooth and of good quality.

Thorburn's Century—From J. M. Thorburn and Co., New York, N. Y. Productive, early and of medium quality.

Trophy—From J. C. Vaughan, Chicago, Ill. One of the best varieties grown. Very productive, firm, and solid; color dark scarlet and of fine flavor. It is medium-late but usually ripens before the frost kills the vines.

Volunteer—From W. W. Kawson and Co., Boston, Mass. A very productive variety, resembling the Ruby, but the fruit is larger and of a brighter color.

Waldorf—From Harry L. Holmes, Harrisburg, Pa. The vines are vigorous and the tomatoes are large, smooth, solid, rose red in color and of good quality. One of the best sorts for home use or fancy market.

Wealthy—From J. Bolgiano and Sons. Promises to be of considerable value. Productive and of good quality.

Fifty Day—From John A. Salzer Seed Co. Is an extra early variety, but too rough to be of value.

YELLOW SORTS.

The following varieties are of especial value for preserving purposes:

Clusterosa—A small, pear-shaped, yellow variety, of pleasant flavor, and quite desirable for preserving purposes.

Golden Queen—Is one of the best varieties of the yellow sorts. It closely resembles the Trophy in growth and shape. It is bright yellow and of excellent flavor.

Golden Strawberry—From James Vick's Sons. Is similar to Red Strawberry except in color. The fruit is very small, is covered with a husk and has an insipid taste. Its only value is for preserving purposes and it is not much used.

Golden Dome—From John A. Salzer Seed Co. Quite similar to Golden Queen, except that it is less firm and solid.

Red Plum—From H. W. Buckbee, Rockford, Ill. A small red variety sometimes used for preserving purposes. It is oval or plum-shaped.

Red Pear—From H. W. Buckbee. Similar to Red Plum in habit of growth and quality but it is pear-shaped.

Silver Egg—Has very strong growing vines and is quite productive. The tomatoes are light yellow, egg-shaped and rather soft. It has no special value.

Sumatra Fig—From John A. Salzer Seed Co. Seems to be identical with Clusterosa.

POTATOES.

The soil is a sandy loam mixed with clay and a good per cent of vegetable matter. It is rather heavy for an ideal potato soil, especially in wet seasons, and although it is well underdrained, the past season was such that the ground was too wet. It was fitted in the same manner as described for tomatoes.

The crop was very free from potato scab, owing to the seed being treated with corrosive sublimate (one ounce in sixteen gallons of water) for about forty minutes before planting. The early varieties were planted May 1st and late sorts on June 18th.

The trench system was followed in planting both the early and late varieties. The rows were three and one-half feet apart and each variety was given forty feet of space in the rows. Nearly one hundred and fifty varieties were grown, two pounds of seed being used for each sort.

The seed was selected at the time of digging. None but the most uniform tubers, true to the type of the variety, were used. The seed was cut into twenty-five pieces, each medium-sized tuber giving four pieces and one piece was used for each hill.

The seed was covered about five inches deep, and the ground was then rolled and worked occasionally with a Breed's weeder as long as it could be used without injuring the plants; then a Planet, Jr., cultivator was used the balance of the season, with level culture.

The Colorado beetle was quite severe in its attack, but by spraying with Paris green in Bordeaux mixture, the damage was slight. The Bordeaux also prevented any serious injury from the attack of the potato blights. In some sections of the State the blight worked serious havoc with the crop, but when the potatoes are thoroughly sprayed, there will be but little injury from this disease.

The crop of early potatoes was unusually fine, both in productiveness and the good quality of the tubers; they were nearly all of good size, clean and very attractive in appearance A display of the early varieties was made at the Michigan State Fair, where many favorable comments were heard, and a collection of the early varieties will be sent to the St. Louis Exposition. There was a large demand for the seed, but the quantity being limited it was impossible to supply it.

The conditions were such that the test of the later varieties was not so satisfactory. The ground being heavier, although it was well underdrained, the excessive rains made the production of potatoes of the highest quality impossible. The yields of the latter varieties were much below the average, on this account.

Seed of the following varieties were secured of Burton A. Corbet, Colebrook, N. H., Dewey Rose, Columbia, Benaiah, Coos No. 1 and Early Coos, among the early varieties; and Pride of Britain, Old Glory, Colebrook, White Brooks, Coos No. 2, Cow Horn, Red American Wonder and Norcross, among the later sorts.

NOTES ON EARLY VARIETIES.

Acme—Of the Ohio type, but usually a better yielder. The vines are of medium size, and can be planted quite closely.

Andes—Has been grown for several years and is an early variety of considerable value.

Arcadia—A very promising new variety. The tubers are white, very smooth, with netted skin, and when cooked are very dry and white.

Benaiah—A new variety that is very productive and the tubers are handsome. They are white, smooth, and are well clustered in the hill. The vines are strong growers and can not be planted as closely as those of the Ohio type, but the yield is much larger than of some of the other early varieties. It seems to be a very promising variety.

Crines Lightning—A quick maturing variety of medium productiveness. The tubers are inclined to be a little rough, but the skin is smooth and of good quality. The vines are upright in growth.

Coos No 1—Strongly resembles Bovee and is of the same type. It is a heavy yielder giving 251.39 bushels per acre. The tubers are white, round, elongated and have shallow eyes. It promises to be valuable.

Coos Early—Of the same type as Admiral Dewey and is said to be a sport from that variety. The yield was 316.18 bushels per acre and showed a large per cent of marketable potatoes. The vines are strong, vigorous growers and the tubers are well bunched in the hills.

Columbia—Promises to be of much value, owing to its vigor of growth and productiveness. The yield was 285.08 bushels of tubers of the best quality. The tubers are uniform in size, have a smooth russety skin and round, elongated form.

Daughter of Rose—Holds up well in yield after having been grown for several years. The potatoes have a slight tendency to be a little rough, but are quite productive.

Dewey Rose—A variety of recent origin that is very productive and among the healthiest in the list. The tubers are large, uniform, slightly elongated and have pink markings. The eyes are of medium depth, well scattered over the surface. It promises to be a leading variety in its class.

Dewdrop—Has been grown for several years and ranks among the better sorts in productiveness and quality.

Early Carman—A new variety of large promise. The tubers strongly resemble Carman No. 3 in color and shape. It is a heavy yielder, the yield this year being 253.98 bushels per acre. The tubers are closely bunched in the hill so that they are easily dug. The vines are upright, strong and vigorous, and were not much injured by blight.

Eureka—Is among the new early varieties. The quality is good.

Hamilton—A new variety whose yield this season was 241.02 bushels of potatoes of superior quality. They are white, very smooth and uniform in size.

Hewes—Is among the heavier yielding sorts, the crop for 1903 being 247.8 bushels per acre. The vines are strong and spreading. The tubers are smooth, slightly elongated, and attractive in appearance. Worthy of a place among the early sorts.

Irish Cobbler—The vines are of medium strong growth and the tubers are elongated, regular and smooth, with a slightly netted, nearly white skin, with shallow eyes. The yield in 1903 was 367.64 bushels per acre. There are few better medium early varieties.

Michigan—One of the best early varieties in productiveness and quality. The tubers are very white, slightly elongated, oval, with eyes shallow. There are few superior early varieties. The yield for 1903 was 300.63 bushels per acre.

Minnehaha—The tubers are a little inclined to be rough. They are slightly elongated and of Early Rose type. The yield for 1903 was 233 25 bushels per acre.

Norther—This variety has been very satisfactory here as well as in other parts of the State. It yields well and is worthy of a place among the medium-early varieties.

Ohio—A leading early variety for many years. The quality is not the best, but it matures quickly and if planted closely will be fairly productive. In 1903 it gave a yield of 246.2 bushels per acre.

Pingree—A medium-early variety of considerable value. The vines are strong, vigorous and quite productive. The tubers are white, smooth, slightly elongated, handsome and of good quality.

Pioneer—A very productive variety, yielding in 1903, 334.32 bushels per acre. The tubers are uniform in size, slightly elongated, pinkish white and generally smooth. Of considerable value for commercial purposes.

Prize Market—A medium-early variety which yielded for 1903, 355 05 bushels per acre, with a very large per cent of marketable size. The vines are especially strong in growth and the tubers are well bunched in the hills. They are white, uniform in size and shape, and smooth.

Quick Crop—A variety whose productiveness makes it of some value, although it does not equal some of the better sorts in quality. The yield for 1903 was 285.08 bushels per acre.

Rose of the North—Of the Rose type. It has a strong spreading habit, and the tubers are elongated, pink in color, with deep eyes. In 1903 the yield was 238.43 bushels per acre.

Rosy Morn—The vines are of medium growth and ripen the crop nearly as early as any. The tubers are roundish, with slight pink markings and quite smooth. The yield was 212.50 bushels per acre.

Salzer—An extra early variety which ranks among the better sorts. The vines are of medium growth and quite productive. The tubers are roundish, of a bright red color and are edible even before they are thoroughly ripe. The yield was 121.81 bushels per acre.

Silver Crown—A very productive, extra early, white variety. The vines are upright, vigorous growers and in productiveness and quality it ranks among the best. The yield for 1903 was 259.16 bushels per acre. The tubers are regular, slightly flattened and a little elongated.

Triumph—Is one of the same class as the Salzer and resembles it very closely both in habit of growth and tubers. The potatoes are bright, pink-red color, nearly round, and usually smooth.

Trimble—Is a white variety that has shown itself of considerable value in productiveness and quality. The yield for 1903 was 219.29 bushels per acre.

White Ohio—Seems to be a sport from Early Ohio, as it has all of the characteristics of that variety, except its color which is pure white. Yields better, for 1903 giving 241 02 bushels per acre.

NOTES ON LATE VARIETIES.

Admiral Schley—One of the newer varieties of the Carman type. It yielded at the rate of 129.58 bushels per acre. The vines were very thrifty, strong growers, and were not affected by the blight to any extent. The tubers are handsome in appearance and of excellent quality.

Big Crop—From Geo. W. Mace, Greenville, O. It does not come up to expectations in yield, although the quality is good.

Bruce '98—From John A. Bruce and Co., Hamilton, Canada. The vines are thrifty, strong growers, and were not seriously affected by the blight. The tubers were uniform but rather small in size. The yield was 121.4 bushels per acre. Quality very good.

California Russet—One of the two russet varieties that has been grown for several years. Of medium productiveness only, but the quality is good for a potato of its type.

Cannon Ball (Salzer's)—One of the best round, red varieties. It yields and keeps well.

Carman Nos. 1 and 3—These varieties have been grown with excellent results for several years. No 3 is the more valuable of the two and is one of the best market sorts. It yields and handles well and is of good quality.

Coos No. 2—Is a strong, thrifty grower. The tubers are long, white, smooth and attractive. They were well bunched in the hill, which makes it much easier to dig them. The yield was very promising, being 181.47 bushels per acre.

Colebrook—Is of the Hebron type. The vines are of medium growth, upright and stocky. The tubers were somewhat scattered in the hill, and do not grow very deep They rank as a second early, and medium in productiveness. It is worthy of trial.

Columbian—Has been grown for the last three years and, while the appearance and quality are good, they lack in productiveness for commercial purposes. They are a white, attractive potato.

Commercial—This ranks very high in productiveness. The tubers are a little inclined to be rough; the eyes are rather deep. Color, pink.

Cow Horn—A long, slim, white variety. The skin has fine, netted markings; eyes are shallow, scattering; quality good, and they seem to be good keepers. The vines are vigorous and of medium productiveness. This type of potato is not desirable.

Dewey—Of the Carman type. It yields well and is smooth, handsome and of good quality

Enormous—Yields well, but is too rough and coarse to be of value.

Farmers' Favorite—This variety has been grown for two years, and, while only medium in productiveness, it has few superiors in quality.

Free Silver and Free Trade—Are also of the Carman type and are almost identical. They have handsome tubers and yield fairly well.

German Rose—Has some value as a market sort. It yields and sells well.

Good Times—Is a variety similar to Free Silver and Free Trade.

Governor Yates—Is a promising sort but it is not better than several others of the Carman class.

Green Mountain—It yields well and the tubers are handsome in form and color. It seems to be less injured than most varieties by blight.

Hiler's Choice—A pure white potato and the tubers are even in shape and size and quite smooth. Quite productive and desirable as a market sort.

Home Comfort—A white potato of attractive appearance, but it has not been sufficiently productive to warrant general planting.

Kaiser Krone—Of the Carman type and seems to have considerable value. It is very handsome and of the best quality.

Maggie Murphy—Has been grown for eight years and has given an average of more than 200 bushels per acre. The tubers have pink markings, and are rather rough, but it yields and keeps well. The vines are very thrifty and strong.

Mark Hanna, Million Dollar and McKinley are nearly identical. They are of the Carman type and have few superiors in quality, besides being handsome and productive.

Michigan Beauty—This variety has been grown for several years and have averaged nearly 200 bushels per acre. The tubers are long, slightly flattened, white and attractive.

Norcross—Originated in Auburn, Me, about ten years ago. A medium-late, white variety of the Green Mountain type, but yields better than that variety. The vines are strong and thrifty, and it keeps and cooks well.

Pride of Britain—A white potato of much promise. The vines are strong and thrifty; tubers, regular, oval, slightly elongated, smooth and attractive. The keeping qaulity seems to be good.

Red American Wonder—Of American Wonder type, but is of bright red in color. It seems to be equal to the old variety in quality and productiveness.

Rural New Yorker No. 2—Has been the standard commercial variety for many years, but owing to its inferior quality, other varieties are fast taking its place.

Sweet Home—Is of superior quality, but seems to lack in productiveness.

White Brooks—Vines strong growers with a spreading habit and fairly productive Tubers white, of the Burbank type, and inclined to grow rough, which is a serious objection from a commercial standpoint.

EXPERIMENTS WITH SUGAR BEETS IN 1903.

C. D. SMITH, DIRECTOR.

Bulletin No. 215.

SUMMARY.

1. The variation in sugar content of adjacent beets in the same row grown from the same seed under identical conditions, is so great as to make the gathering of samples certain to accurately represent the whole plot, or a whole field, in per cent of sugar, extremely difficult if not impossible. In the case reported in this bulletin this difference in sugar content of adjacent beets amounted to over 3% in one instance and frequently over 2%. Had the average sugar content of the plot been estimated from every fifth beet it would have been more than 1% different from the estimate made from the analysis of every sixth beet. It is unsafe therefore to draw conclusions as to the estimated amount of sugar in a field of beets from the analysis of ten or even twenty samples taken either at random or systematically from the field.

2. The shrinkage in weight of beets sent to the station by mail for analysis is sufficient to make a gain of from 3% to 4½% in sugar content It is not safe therefore, to judge of the sugar content of a field of beets by tests made at a distant laboratory unless careful record is made of the weights of the beets when taken from the ground and upon arrival at the laboratory.

3. Lifting the beets seems to prevent, in one instance, the change of composition of the beets so treated and leads to the probability that thus treating a field of beets at the conclusion of a long hot, dry period and preceding rain will prevent the usual extreme decline in sugar content due to the second growth which takes place when the tap root is left undisturbed.

4. The weight of the tops and crowns constitute from 40% to 44% of the weight of the topped roots; the crowns approximately 20% and the leaves the same.

5. The farmer has but little control over the per cent of sugar in his beets. If he grows them on undigested muck or apply nitrate of soda after the first of July, he may increase the tonnage at the expense of the per cent of sugar, otherwise he can influence but little, if any, the quality of the crop. The richness in sugar depends upon the season, the presence or absence of long periods of continuous sunshine, next upon the soil, the sandy loams giving richer beets in one season and the clay loams on another, and finally upon the seed. The seed furnished the farmer by the factory should be such as to be prepotent in three directions. It should produce a good tonnage; next, it should produce beets rich in sugar under all ordinary circumstances, on good soil, with a normal season; next, it should produce a crop of beets of uniform richness, that is, one beet should not be rich and the next poor in sugar. The experiments reported in former bulletins and in this one show that the beet seed received at the average Michigan factory does not fulfill all three of these conditions' Beet seed as sent out by the factories is imported from a foreign country. It is supposed to be a product of many generations of careful selection and scientific breeding. The abilty to produce beets of uniform excellence is not yet sufficiently fixed to warrant the expectation, that, where a field is sown to beet seed either imported or grown in America, the beets will all, or the majority of the beets contain 15% of sugar or more.

The variety tests at Holland, Detroit and Saginaw showed a wide variation in the per cent of sugar in beets of the same variety when grown under varying conditions. They did not show the superiority of any one variety on all three types of soil.

6. The not infrequent abuse of the soil by growing three crops of beets in succession on the same land is shown to be exceedingly injurious, the crops growing on the soil thus abused being less than on adjacent plots where a normal rotation is followed, this decrease in yield being shown for at least two years after the growing of the beets.

7. Economy demands that the rows of beets shall be no nearer together than is necessary for the maximum yield. As a result of observations for five years it is recommended that the rows be no nearer than twenty inches and that on all ordinary soils not treated with stable manures or commercial fertilizers, the distance may well be twenty-four inches or even twenty-eight inches.

8. It pays to use commercial fertilizers containing nitrogen, phosphoric acid and potash, at the usual prices. Most soils need all three constituents. Taking the experiments of 1903 in connection with those which preceded them, it is safe to conclude that the nitrates are always in demand even on the richest soils. They should of course be applied early. Potash is needed on nearly all Michigan soils. Phosphoric acid increases the yield in every case except on a soil giving nearly fifteen tons to the acre without the addition of commercial fertilizers. On all soils except the last, all three ingredients mentioned are needed and their application is profitable. The amount of seed per acre and the work required is the same except at harvest, with a crop of eight as with a crop of fifteen tons. If, therefore, the application of the fertilizers increases the yield per acre to an amount equal to the cost of the fertilizers, it still pays to use them. In the experiments reported here the increment is greater than the cost of the commercial fertilizers.

9. Spraying with Bordeaux mixture decreases the amount of blight and when the proper tools for spraying economically are invented it will undoubtedly pay to spray the beet fields to prevent this disease.

I. PRELIMINARY INVESTIGATIONS.

The measure of the value of a crop of sugar beets is the sugar contained and in our calculations heretofore, the unit of value has been the estimated amount of sugar produced on an acre. Where, for instance, varieties of beets have been compared, they have been sown on adjacent plots and, at harvest time the beets on each plot had been weighed and a half dozen beets from each plot had been pulped together and tested for sugar under the assumption that the per cent of sugar in the few beets thus taken was identical, or approximately so, with the per cent of sugar in the whole plot. Naturally, it is inconvenient if not impossible to grind up all of the beets on the plot and make a composite test of such magnitude. In selecting the sample beets for analysis they have sometimes been pulled hap-hazard without plan, again, after the plot has been harvested and weighed, beets of average size and typical in shape of the given variety have been taken from the loads; again, before harvest every fifth or sixth beet has been taken, or one every two paces, or one from each square rod. Various circumstances have given rise to suspicion that these few beets were not certain to fairly represent the plot from which they were taken. A few observations bearing on this question are here recorded.

1. *Testing each beet in the row*—Some seed, received from Dr. Wiley, of the Department of Agriculture, had been sown in a plot of fairly homogeneous soil. Considering the source of the seed it is fair to suppose that it was from selected mothers and uniform in quality. A single row in the middle of the plot, some eight rods long, contained fifty-nine beets. They were pulled and numbered according to the location in the row, with results following:

No.	Per Cent Sugar.	No.	Per Cent Sugar.
1	15.0	31	14.6
2	....	32	14.1
3	15.2	33	....
4	14.5	34	14.2
5	13.4	35	15.8
6	....	36	14.9
7	13.6	37	15.0
8	....	38	15.1
9	15.6	39	15.0
10	12.6	40	13.0
11	13.1	41	13.8
12	14.4	42	....
13	14.2	43	15.0
14	16.2	44	16.3
15	14.1	45	14.8
16	15.2	46	14.3
17	14.8	47	14.1
18	15.3	48	13.5
19	....	49	14.2
20	15.4	50	12.8
21	14.5	51	....
22	15.8	52	14.5
23	15.1	53	13.7
24	14.2	54	14.4
25	15.5	55	11.1
26	15.1	56	....
27	14.8	57	13.2
28	12.4	58	14.0
29	15.1	59	14.6
30	15.0		

This little table reveals the wide divergence in sugar content of beets grown under idenitcal conditions from the seed from the same source. Every one who has had to test beets grown from the seed of the same mother beet knows how widely they vary in composition. They have not yet been bred long enough to insure the production of seed by a single mother beet of such uniform excellence as to insure a high per cent of sugar in all of the beets grown from it. Under average field conditions in Michigan the seed furnished by the factories could not be expected to be carefully selected when it is remembered that it is imported from a foreign country without opportunity on the part of the factory purchasing it to make careful inspection as to its ancestry and the methods used in both preventing adulteration and eliminating inferior stock. In ordinary field conditions a still wider variation in sugar content of adjacent beets would naturally be expected. The selection of a few beets here and there over the field gives but little indication, upon analysis, of the average sugar content of the whole field.

2. *Two methods of gathering samples compared*—From a tenth acre plot, Prof. Robison and his assistant selected one beet every five paces until every row in the plot had been canvassed Forty-five beets were thus selected, the composite sample of which showed 14% sugar with a purity 83.9. Next ten beets were selected at random, taking care to divide the beets among the low and high areas so that each soil type would be represented. A composite sample of these ten beets showed a sugar content of 13.2% with a purity of 80.0. In our work with varieties therefore, a variation of .8% or even 1% is not significant and even larger variations may be due to samples misrepresenting the plot rather than to any real difference in the prepotency of the seed.

3. *Shrinkage of beets in transit through the mails and consequent increase in sugar content*—Since the per cent of sugar in the beets indicates the relation between the weight of the beet and the weight of the sugar it contains it is evident that if the sugar remains constant and the weight of the beet decreases by reason of drying out, the per cent of sugar will be increased. This of course does not mean that there is any more absolute sugar in the beet but that the sugar constitutes a larger proportion of the total weight of the beet Beets are frequently sent to the station for analysis. The request is made that the sample be analyzed

and a report made to the sender. The weight of the beet when pulled, cleaned and topped, fresh from the ground is never sent with the beet so that the station has no means of knowing how much the weight of the sample has shrunk in transit. A test of the wilted, dried specimen as received at the college could naturally not give the per cent of sugar in the beet as it left the field of the grower. The amount of this shrinkage is a matter not fully understood.

Supt. L. M. Geismar of the Upper Peninsula Experiment Station wrapped some beets separately in cloth and for a second covering, in paper, and mailed them to the home station at the Agricultural College, a distance somewhat more than four hundred miles. He weighed the beets as sent. They were re-weighed when analyzed The per cent of sugar at Chatham and at the College, with the apparent gain in richness is shown in the next table.

	Per Cent Sugar at Chatham.	Per Cent Sugar at the College.	Per Cent gain.
No. 1	16.1	20.6	4.5
No. 2	14.5	17.8	3.3
No. 3	16.8	20.2	3.4
No. 4	15.4	18.6	3.2
No. 5	16.5	19.6	3.1
No. 6	14.6	18.4	3.8

There is a difference in the amount of shrinkage experienced by these six beets, but in general it is safe to say that there was shrinkage enough to account for a variation of over 3% in the sugar content.

In late October a couple of beets were sent by mail, well wrapped in paper and sewed in sacks, to Saginaw. They were not opened there but were returned at once to the station. Sample 1 had the leaves stripped off but the crown remained. Sample 2 was topped in the usual way. Sample 1 lost 13.79% in weight and sample 2, 12.90%. In other words, if both beets had tested 16% before their journey, sample 1 would have gained 2.56% in sugar and sample 2, 2.40%. It required seventy-two hours to make the journey. These beets were better protected from evaporation than are the average samples.

4. *Effect of lifting on sugar content*—Frequently after an extended period of warm dry weather in late September and October, a heavy rain starts a new growth on the beets and the per cent of sugar rapidly falls. It is generally believed that if the beets be lifted in the usual way, breaking the tap root and tearing apart most of the lateral roots, the per cent of sugar will not fall. No good opportunity to test the matter presented itself in 1903 as the season was wet throughout. An experiment was undertaken however to furnish some data on the question of the influence of running the beet lifter under the rows on the sugar content of the beets so treated. Analyses were made as soon as the beets were lifted and again after four days had elapsed after the beet lifter had been run under the three rows taken for the test. Ten beets were taken from each row at each analysis, making sixty beets in all. The average of the first analyses was 14.3% and of the second 14%, showing little variation in sugar content in the four days which means of course that the beets dried out but very little and that there was little, if any, new growth and no fermentation.

5. *Relation of the weights of roots, crowns and leaves*—Two trials were made in this matter. In the first, 760 lbs. of clean untopped beets were topped in the usual way. The topped beets weighed 530 lbs., the crowns 120 lbs., and the leaves 110 lbs. This makes the crowns weigh 22.6% of the weight of the topped roots and the leaves, 20.7% of the topped roots The weight of the leaves and crowns together was 43.3% of the weight of the topped roots.

In the second trial, 865 lbs. of clean untopped beets were taken. The topped beets weighed 620 lbs., the leaves 130 lbs., and the crowns 115 lbs. The leaves were in weight 21% and the crowns 18.5% of the topped 22.6% of the weight of the topped roots and the leaves, 20 7% of the topped beets or the leaves and crowns together 39.5%. The plots from which these beets were taken yielded approximately twelve tons to the acre. Before pulling, the tops appeared less than average in size.

II. VARIETY TEST.

The plan adopted in making the test of varieties in 1903 was identical with that of 1902. Each of the factories contributed ten pounds of seed of the varieties used by their patrons. This ten pounds was divided into three parts and the test carried

on in triplicate. Mr. Albert Wilterdink kindly allowed us the use of one of his fields, two and one-half miles southeast of Holland. This field had borne clover in 1901 and corn in 1902. The soil was mostly a clay loam, running into sandy loam, was gently rolling and well drained. A commercial fertilizer containing all three elements, nitrogen, phosphoric acid and potash was used at the rate of five hundred pounds per acre. Seed was sowed in rows twenty inches apart. The soil was in good condition when the seed was planted and Mr. Wilterdink gave the crop most excellent cultivation throughout the season.

Through the courtesy of Mr. Stuart Morrison, manager, a field of the Sheridan avenue farm of the Saginaw Realty Company, was set aside for this test and others. The soil was alluvial, dark sandy loam, very fertile and in an excellent state of cultivation.

Near Detroit, on the farm of Mr. Wm. Reed, a series of plots were used for the triplicate test.

The varieties tested and the source were as follows:

Seed from David Sachs, Quedlinburg, sent by the Saginaw Sugar Company; Rabbetge and Geisecke Original Kleinwanzlebener, from Holland Sugar Co.; Original Kleinwanzlebener, Meyer and Raapke, from the Detroit Sugar Company.

Seed A, from the Sebewaing Sugar Company;

Seed B, from the Sebewaing Sugar Company;

Hoerning's Kleinwanzlebener, from the German-American Sugar Company;

Hoerning's Improved Kleinwanzlebener, from the Peninsular Sugar Company;

Seed from D. Sachs, from the Detroit Sugar Company;

Dippe's Kleinwanzlebener, from the Detroit Sugar Company;

Original Kleinwanzlebener, Rabbetge und Geisecke, from the Holland Sugar Company;

Seed from the Michigan Sugar Company;

Schreiber's Elite, from the Detroit Sugar Company;

Jaensch Victrix, from the Saginaw Sugar Company;

C. Brown Kleinwanzlebener, from the Saginaw Sugar Company;

American grown Kleinwanzlebener, from the United States Department of Agriculture;

Dippe's Improved Kleinwanzlebener, from the German-American Seed Company;

Carl Schubert & Company, Ideal, from Saginaw Sugar Company;

Otto Hoerning's Kleinwanzlebener, from the Saginaw Sugar Company;

C. Vorstadt, from the Saginaw Sugar Company.

The season was wet throughout but none of the fields were ruined by the floods although the one on the farm of the Saginaw Realty Company was overflowed for days at a time. The harvest was wet and delayed. There elapsed therefore considerable time between the harvesting of the beets and the delivery to the factory. In the next table there is given the per cent of sugar in the beets as determined by a composite of ten or more single beets from each plot, the test made at the station laboratory. In the next column is given the per cent as found by the factory when the beets were delivered.

	Holland		Detroit		Saginaw	
	Station.	Factory.	Station.	Factory.	Station.	Factory.
Schreiber's Elite	18.2	16.9	15.2	15.6	16.2	16.2
American Grown	16.1	15.6	15.2	....	14.5	....
Carl Schubert Ideal	17.3	16.5	14.7	16	14.4	12.6
Dippe's Improved Kleinswanzleben	16.6	17.5	14.8	15.4	14.6	13.2
Rabbetge und Geisecke Original Klein	17.5	17.4	16.1	....	15.2	13
Sebewaing A	16.5	14.5	15.4	....	14.6	14
Sebewaing B	17.3	17.8	15.5	....	15.6	15.2
Meyer und Raapke, Original	17.2	18.4	16.3	16.6	15.3	15.2
Dippe's Kleinwanzleben	17.4	17.3	15.1	15.7	15.3	14.3
Rabbetge und Geisecke Original Klein	18.5	17.5	16.3	15.5	15 2	14.2
Michigan Sugar Co	17.7	17	....	15.6	16.2	13.8
Hoerning's Elite	16.5	16.7	15.1	14.9	14.8	12
Hoerning's Improved	16.7	16.2	13.3	15.2	15.2	14
Otto Hoerning	16.4	16.6	14.3	15.7	14.5	14.4
Sachs'	15.5	16	14.2	16.1	14.2	13.4
C. Vorstadt	16.8	16.1	13.5	15.5	15.3	13.8
Jaensch's Victrix	17.3	16.6	15.4	15.7	....	13.2
C. Bronne	17.3	16.2	14.8	16.1	14.8	13.4
David Sachs	16	15.6	14.8	....	15.2	15

Owing to the wet harvest it was impossible to lift, top, haul and weigh these plots on the same day or even in the same week. At Saginaw the beets had to lay in heaps for several weeks, the field meantime being very wet and part of the time almost under water. These facts account for the discrepancies between the tests at the factory and at the station. Moreover the beets were wrapped up in cloth sacks and taken to the experiment station by freight, necessitating some delay and some shrinkage. With the original per cent of sugar in the beets the same, the tests should show higher at the college than at the factory.

A test of varieties aims to determine which of the varieties compared gives the richer beet. A farmer has but little control over the per cent of sugar in his beet crop. He can neither increase nor decrease it by cultivation, by neglect, by want of commercial fertilizers or by excess of commercial fertilizers, with the single possible exception of the application of an excess of nitrate of soda late in the season, which tends to give a large tonnage with low per cent of sugar. Where he is paid for his crop according to the richness in sugar it is a matter of prime importance to him that the factories furnish seed which shall produce beets with high per cent of sugar, since the quality of his whole crop depends upon the quality of the seed, more than upon all the rest of the factors influencing the crop put together.

That the kind and condition of the soil have a cogent influence on the quality of the crop is manifest by a cursory examination of the table just given. The average per cent of sugar in the beets at Holland was much higher than at either Detroit or Saginaw. The soil at Holland was a very sandy loam. At Detroit it was also a sandy loam, rather more alluvial than at Holland and with more humus. At Saginaw it was more humic and contained a great deal more clay. Under the weather conditions existing in 1903 the beets were richer on the loamy soil at Holland.

In 1902, also a very wet season, the average per cent of sugar in twenty-one varieties was higher on the Goodnoe farm, with its stiff clay subsoil and black, humic, alluvial surface soil than at either Alma, on stiff clay, or at the College, on the sandy loam. (See report of Michigan Board of Agriculture, 1903, p. 185.) "These findings are interesting, especially when it is remembered that the Goodnoe soil was almost a muck and lay so low that it was flooded with water for the entire season except in spots large enough to furnish samples for analysis, and on these spots the water was so close to the surface that the beets were round and turnip-shaped rather than conical."

It would be interesting to determine which variety or varieties were best adapted to the different kinds of soil used in the experiment in 1903. The foregoing table gives but little light on that topic. In fact any conclusion drawn from the figures in the table would be unsafe since there is little assurance that the entire plots differed in richness in sugar exactly as the small samples taken from those plots differ. The factory tests could not be used in this study because the beets were not all drawn to the factory from the different plots on the same day. Some plots had shrunken more in weight than others when the tests were made. Until the breeding of the beet seed is carried to the point where the great majority of the beets grown from the seed will be uniform in sugar content and until larger samples, known to fairly represent the entire crop are taken for analysis it will be unsafe to draw conclusions from tabulated records of analyses.

The yields of the several varieties as determined by the weights of the plots at the factories are given in the following table. This table must be considered remembering that the harvest was exceptionally wet, that the crops from adjacent plots were hauled at different dates and therefore under varying conditions and that some of the yields had been buried and partly frozen while others escaped that hostile influence. At Saginaw, the conditions were so adverse that the yields are not given. The weights given are of clean beets, the tare out.

Variety.	Yield per acre, Holland. Lbs.	Yield per acre, Detroit. Lbs.
Schreiber's Elite	23,824	......
Schubert's Ideal	24,690	14,960
Dippe's Improved Kleinswanzleben	24,000	16,500
Rabbetge und Geisecke Original	25,930	14,410
Sebewaing A	23,637	24,772
Meyer und Raapke Original	23,368	23,452
Dippe's Kleinswanzleben	24,871	14,014
Rabbetge und Geisecke Original	22,623	25,366
Michigan Sugar Co	22,193	18,260
Hoerning's Elite	24,023	21,428
Hoerning's Improved	21,538	24,684
Otto Hoerning	23,275	14,740
Sachs	22,070	......
C. Vorstadt	24,175	16,700
Jaensch Victrix	21,830	16,390
C. Bronne	26,080	12,430

III. EXHAUSTION OF THE SOIL BY BEETS.

In Bulletin No. 207 (Board Report for 1903, p. 188), there is given a report of an experiment to test the influence of cropping a light sandy loam with beets for three successive years The work was continued through the year 1903. It will be remembered that of a whole area which had been planted to *Lathyrus silvestris* in 1890 and had borne that crop without plowing until 1898, a strip eighty feet wide running north and south through the field which was sixteen rods wide had been planted to beets for three years in success on, while east and west of this strip other plots parallel to it had for the same three years produced crops of oats, millet, clover or alfalfa. The history of the several plots was given in the bulletin referred to and need not be repeated here. In 1903 the north strip of seventy-two feet in width which in 1902 had been sown to oats, was this year planted to sugar beets, the rows running east and west, eighteen inches apart and the seed being furnished by M. Knauer of Germany. The next strip south of the beets was planted on the 18th of May to White Dent corn in hills three feet nine inches apart each way. This strip was seventy-nine feet wide. The south strip of all, 144 feet wide, was drilled to oats on April 21, using one and one-half bushels of seed per acre.

The area which had borne beets for three years in succession crossed these three crops near the middle of their length and by the 30th of May the corn, oats and beets had begun to show the bad effects of this successive cropping to beets, the crops on the area which had borne beets so long being very visibly lower in height and bad in color.

The beets were thinned on June 6th and were cultivated and hoed at frequent intervals during the summer, the very wet season requiring by reason of the growth of weeds, an unusual amount of cultivation. The oats were harvested August 1st, the corn on September 25th, husked October 10th, and the beets, lifted and topped October 17th, were hauled and weighed October 26th. The following table gives the yields, of the several crops, calculated to yields per acre. Remember, that plot 3 had borne beets for the three years, 1899, 1900 and 1901, and plot 4 had borne beets in 1899 and 1900 and oats in 1901, while plots 1, 2, 5, 6, and 7 had been treated to various rotations, there being legumes in all the rotations except on plot 1, which had grown *Bromus inermis* continuously for the three years named.

YIELDS PER ACRE OF OATS, BEETS AND CORN.

	Oats.		Beets.		Corn.	
	Grain, pounds.	Straw, pounds.	Pounds.	Per cent sugar.	Ears, pounds.	Stalks, pounds.
1	1,184	3,605	15,368	14.2	4,856	5,048
2	1,409	4,123	25,009	13.4	5,669	7,293
3	303	1,345	15,968	14.7	3,289	3,400
4	1,065	1.557	22.688	14 1	4,606	5,272
5	886	2,848	23,772	13 5	5,093	4,139
6	1,122	2,560	26,146	13.7	5,818	5,000
7	1,232	3,398	25,359	15.4	4,929	4,551

It is noted at once that plot 3 which had been abused by being compelled to bear three successive crops of beets gave us a much smaller yield of all three crops, oats, beets and corn, than did the plots on either side, and that plot 4, although located where the ground was normally somewhat richer than plots 1 and 2, gave a less yield of beets and corn than any other plots save plot 1. Further comment is not needed as the sole aim of the experiment was to find out how seriously following beets with beets for three successive years would injure the productive capacity of a light sandy loam.

IV. DISTANCE APART OF ROWS.

This station has conducted experiments for several years to accumulate data bearing on the question of the most economical and profitable distance apart of rows for sugar beets under normal conditions. In 1902, the conclusion is reached that "In this country, where the work is to be done largely by horses and where the land is seldom as well fertilized as in Europe, the distance between rows may well be maintained at twenty inches to twenty-two inches, and certainly at not less than eighteen inches." The experiments in 1902 compared the distance sixteen inches, eighteen inches, twenty inches, twenty-two inches, and twenty-four inches. There was no relation between the width of rows and the per cent of sugar in the beets nor did the yields vary widely as between these different distances. In 1903, it was found impossible to continue the experiments on the college farm by reason of lack of suitable soil. Gov. A. T Bliss consented to have the experiment tried upon his farm at Carrollton, under the supervision of his most efficient foreman, Mr. J. W. Wood. Here the distances were as follows:—The first thirty-six rows were twenty-one inches apart, the next twenty-seven rows twenty-eight inches apart, the third thirty-six rows twenty-one inches apart, the fourth twenty-seven rows twenty-eight inches apart and on the fifth and sixth plots there were 44 rows each, eighteen inches apart. The first four plots were therefore 756 inches wide while plots 5 and 6 were 798 inches wide. Calculating the yields to the even width of 756 inches, we have the following table:

Plot.	Yields, lbs.
1	8,879
2	10,905
3	11,090
4	12.149
5	12,942
6	10,270

It thus appears that the two plots with rows eighteen inches apart yielded 23,212 lbs., the two plots twenty-one inches apart, 19,969 lbs., and the two plots twenty-eight inches apart, 23,058 lbs. Here there seems to be no relation between the yields and the width of rows. There is a difference, however, in the amount of work required to cultivate the crop on an acre, depending on the width of the rows, and if it is possible to grow as many pounds of beets as rich in sugar in rows twenty-eight inches apart as in rows eighteen inches apart, the former distance should be adopted.

The richness of these beets in sugar, therefore, becomes a matter of consequence. On the 16th of October, samples were taken for analysis, the ground at that time being almost covered with water, the soil completely saturated. The following table gives the result of the test of these samples:

Plot.	Per cent sugar.
1	15.3
2	14.6
3	14.4
4	13.1
5	14 6
6	15.4

Note that the variation in per cent between plots 5 and 6 was quite marked, almost as much so as between adjacent plots where the distance apart of the row had been varied. It would be quite unwise therefore to ascribe the differences in the richness of sugar on the adjacent plots to the differences in the width of the row, the number of beets taken being too small to insure a fair representation of the plot.

The beets were hauled to the factory in the latter part of October. Here from each plot four or five half bushel samples were taken. A test of these samples gave the following results:

Plots	Per cent sugar.
1	13.2
2	12.8
3	12.6
4	12.8
5	12.6
6	12.7

Here there is no relation apparent between the per cent of sugar and the distance apart of the rows. This work confirms the conclusion reached last year that up to twenty-eight inches at least, the increase in the width of the row does not lessen the per cent of sugar in the beets.

Certain officers of the Sebewaing Sugar Company were planting a field to beets and kindly consented to undertake some experiments for the station on this question of the distance apart of rows. The work was very carefully done and the table below gives the yield per acre of the beets on the plots with the distance between the rows named:

Plots.	Distance between rows.	Seed per acre, lbs.	Yield of beets per acre, lbs.
1	18	15	17,393
2	20	15	19.521
3	22	15	18,051
4	18	15	19,363
5	20	15	20,777
6	18	20	22,703
7	18	15	31.094
8	20	15	27.763
9	18	20	21,007
10	18	in hills	23,426
11	18	20	30,577

Comparing the sum of the yields of the plots having rows eighteen inches apart with those having rows twenty inches apart, seed per acre being fifteen pounds, it is found that the yield for the eighteen inch rows was 22,617 lbs. per acre and for the twenty inch rows, 22.687 lbs. per acre. The size of each plot was seven-tenths of an acre. The plot with rows twenty-two inches apart was sown with a hand drill and did not have as good a stand as the other plots. These results do not show any advantage in the eighteen inch row over the twenty-inch row. Plots 6, 9 and 11 had twenty pounds of seed per acre. Comparing the average of

the yields of these three plots with the average of the yields of the three other plots with rows the same distance apart and fifteen pounds of seed per acre, it is found that twenty pounds gave an average yield of 24,762 lbs. and the fifteen pounds of seed per acre, 22,617 lbs., showing a good economy in applying the larger amount of seed.

Plot 10 had the rows eighteen inches apart and the seed was put in with a hill dropper which left one seed at each eight inches of row. Here the yield was 22,436 lbs., not quite as large as the average of the three plots sown in th usual way but the expense of thinning was considerably less than that of any other plot in the series.

The analyses of the beets either at the station or at the factory show no relation however between the width of the row and the per cent of sugar in the beets.

Mr. Albert Wilterdink, besides carrying forward for the station the tests of varieties on his farm near Holland, consented to try some experiments on this question of the width of rows. He had three plots, each .256 of an acre, one drilled in rows eighteen inches apart, the next twenty inches and the third twenty-two inches. The yields were as follows, in pounds per acre of clean and topped beets:

	Yield per acre.
18 inches	23,113 lbs.
20 inches	22,980 lbs.
22 inches	21,823 lbs.

Here the difference in yield slightly favored the narrower row but still not in amount sufficient to pay for the extra length of row and consequent greater cost of thinning and cultivating.

In concluding our work on this important factor of beet growing, the conclusion seems inevitable that a row narrower than twenty-two inches is never advisable except upon the very richest soils while a wider row, up to twenty-eight inches is surely more economical and profitable on soils of average fertility.

V. FERTILIZER EXPERIMENTS.

Two sets of experiments were conducted for the station, testing the influence of the application of various combinations of commercial fertilizers on the yield of sugar beets. What fertilizers are needed for beet production is determined primarily by the composition and physical constitution of the soil. There can never be devised a formula which shall give the best proportions of nitrogen, phosphoric acid and potash for sugar beets on all soils. One soil is lacking in sufficient potash to produce a maximum yield of beets while another has sufficient potash but lacks phosphoric acid. There are few soils in the State upon which the application of all three of these dominant fertilizing factors will not produce increased yields.

The fertilizing experiments such as those to be described below are primarily therefore, tests of the needs of the given soil and cannot aid in performing an impossible task, namely, in devising a formula of universal application. Each farmer must test the matter for himself upon his own farm, each farm on a given typical soil area having a different history and therefore a different appetite for fertilizers. To ask the soil which fertilizing ingredient it most needs, he must lay off plots of equal size upon one of which shall be applied a strong nitrogenous fertilizer, upon the next phosphates and upon the third potash salts. He may wisely go further and apply the combinations used in our work to thus determine upon which ingredient the emphasis should be laid, normal quantities of the others being supplied. These experiments are therefore reported, not as accumulating data to determine a formula of wide application, but as illustrating the increase in yield that may be expected from the application of the fertilizing materials named upon the kinds of soils described.

The claim is not made that these commercial fertilizers can in any way take the place of barnyard manures. The latter, besides supplying nitrogen, phosphoric acid and potash, bring to the soil humus and humus-making materials and a host of bacteria useful in setting free the plant food already existing in the soil. The humus aids in increasing the water holding capacity and, with the bacteria, brings about the chemical and biological actions which help to make available the stored up plant food.

Because no suitable land was available at the college, the tests reported below were carried forward at Holland with the kind and efficient cooperation of Mr. J. A. Wilterdink and near Detroit, on the farm of Mr. C. McDonald. Both of these gentlemen cared for the crop with great assiduity, allowing no weeds to grow and keeping the cultivation up to a very high standard. The season was phenomenally wet and the results are not what might have been expected under more normal weather conditions. The arrangement of plots in both places and the fertilizers applied to each are set forth in the following table:

Plot 1—No nitrogen, 200 lbs. phosphate, 100 lbs. potash.
Plot 2—200 lbs. nitrates, 200 lbs. phosphates, 100 lbs. potash.
Plot 3—Nothing.
Plot 4—100 lbs. nitrates, 100 lbs. potash.
Plot 5—100 lbs. nitrates, 200 lbs. phosphates, 100 lbs. potash.
Plot 6—100 lbs. nitrates, 400 lbs. phosphates, 100 lbs. potash.
Plot 7—Nothing.
Plot 8—100 lbs. nitrates, 200 lbs. phosphates, no potash.
Plot 9—100 lbs. nitrates, 200 lbs. phosphates, 200 lbs. potash.

The amounts stated are given in pounds per acre. The nitrate was in the form of nitrate of soda, the potash was in the form of sulphate of potash (49.10% actual potash), and the phosphate, a dissolved South Carolina rock (17% available phosphoric acid). The yields per acre of beets are stated in the following table. The tare is taken out.

Plot.	Holland.	Detroit.
1	25,598 lbs.	30,550 lbs.
2	34,282 lbs.	36,420 lbs.
3	20.942 lbs.	29,320 lbs.
4	24,888 lbs.	28,258 lbs.
5	28.372 lbs.	35,980 lbs.
6	28,948 lbs.	32,920 lbs.
7	18,760 lbs.	28.320 lbs.
8	27,270 lbs.	36,350 lbs.
9	30,940 lbs.	35,740 lbs.

Both series of plots show the benefit from each of the fertilizing elements. The average of the nothing plots at Holland being 19,851 lbs., and at Detroit, 28,820 lbs., amounts much less than shown by any other plot in the series, except plot 4 at Detroit.

At Holland the application of the nitrates increased the yield of plot 2 over plot 1, and of plot 5 over plot 1, although plot 5 gave a less yield than plot 2, undoubtedly because it received 100 lbs. less of the nitrate of soda. The same statement is true concerning the work at Detroit. Here also, plots 2 and 5 have a larger yield than plot 1, and plot 2 has a larger yield than plot 5, plot 2 having 200 lbs of nitrate and plot 5, 100 lbs., and plot 1, none.

Comparing next, plots 4, 5, and 6, to note the influence of the phosphoric acid, the yield at Holland of plot 6 is found to be greater than that of 5, and the yield of the latter greater than that of 4, showing the need of phosphoric acid in that soil to bring out a maximum crop. At Detroit both 5 and 6 yield more than 4, but there is evidently not the need of phosphoric acid here that was shown in Holland as the yield of plot 6 is less than that of 5.

Potash was needed at Holland as shown by the yields of plot 8 with none, 5 with 100 lbs., and 9 with 200 lbs. per acre. The results do not point to any such need in the rich soil at Detroit which had been farther strengthened by liberal applications of manures in the years preceding this test. Even here, however, the application of the commercial fertilizers paid in the increased yield.

Bearing on the influence of fertilizers on the growth of beets, the following table from series of experiments planned for another purpose will be of value. A series of plots was laid out in 1896 to test the influence of the annual application of certain fertilizers to the yields of crops in a fixed rotation. Beets was one factor in that rotation. The plots had borne crops in years preceding as follows:

1889, oats; 1890, oats; 1891, oats; 1892, oats; 1893, oats; 1894, wheat; 1895, clover; 1896, wheat; 1897, clover; 1898, clover.

Up to 1899 no rotation had been adopted, the plan being to determine something as to the individuality of each plot. That question cannot be discussed here nor will the yields of the other factors in the rotation be given. The following table will record the yields of beets on the separate plots, rejecting plots 8, 10, and 12, which are situated in a hollow and cannot therefore be used. The fertilizers on the different plots are given. Each plot contains one-tenth acre of which the beets occupy a quarter or four square rods. The fertilizers applied to the plots annually were:

Plot 2—Two tons of stable manure.
Plot 4—24 lbs. dissolved phosphate rock.
Plot 14—12 lbs. nitrate of soda and 24 lbs. dissolved phosphate rock.
Plot 16—12 lbs. nitrate of soda, 12 lbs. muriate of potash.
Plot 18—48 lbs. Armour's Fruit and Root Crop Special.
Plot 20—No fertilizer.
Plot 22—12 lbs. muriate of potash.
Plot 24—12 lbs. nitrate of soda, 24 lbs. dissolved phosphate rock and 12 lbs muriate of potash.
Plot 26—24 lbs. dissolved phosphate rock, 12 lbs muriate potash.
Plot 28—24 lbs. nitrate of soda, 24 lbs. dissolved phosphate rock, 12 lbs. of muriate of potash.
Plot 30—12 lbs. nitrate of soda.
Plot 32—9.5 lbs. sulphate of ammonia, 24 lbs. dissolved phosphate rock, 12 lbs muriate of potash.

The yields of beets on the four square rods in the successive seasons are shown in the following table:

Plot.	1889.	1902.	1903.	For the three years.	Fertilizers.
2	373	660	955	1,988	Barnyard manure.
4	281	409	715	1,405	Dissolved rock.
6	243	515	535	1,291	Nothing.
14	303	691	667	1.661	Nitrate and rock.
16	322	810	690	1,822	Nitrate and potash.
18	342	572	763	1,677	Armour's Special.
20	325	488	574	1,387	Nothing.
22	357	484	655	1,496	Potash.
24	397	647	885	1,929	Nitrate, rock and potash.
26	335	638	765	1,738	Rock and potash.
28	337	598	890	1,825	Nitrate, rock and potash.
30	329	576	637	1,542	Nitrate.
32	335	608	768	1,711	Ammonia, rock and potash.

The other factors in the rotation were beans, potatoes, and corn, all hoed crops. It was to be expected therefore, that since the beets followed a hoed crop in a rotation of which each member was a hoed crop the exhaustion of humus would be rapid, and we should see a wide difference in the yield of the plot receiving barnyard manure and those receiving commercial fertilizers only. The yield of plot 2 was 1,988 lbs. as against 1,929 lbs for plot 24 receiving nitrate, phosphoric acid and potash. This difference is immaterial and is a matter of surprise. The nitrate of soda shows increased yields wherever applied. A study of the figures in the columns reporting the total yields for three years shows that on the college farm nitrogen, phosphoric acid and potash are all needed, and that the application of reasonable quantities is made with profit. What is true for the college farm in this respect is undoubtedly true for most of the farms in Michigan, to which on the average less barnyard manure is applied.

VI. PREVENTION OF LEAF BLIGHT BY SPRAYING WITH BORDEAUX MIXTURE OR MANURING WITH NITRATE OF SODA OR COMMON SALT.

This experiment was conducted in cooperation with the Department of Agriculture at Washington. Dr. C O. Townsend of the Bureau of Plant Industry Division of Vegetable Pathological and Physiological Investigations, kindly furnished the seed and gave full directions for carrying out the work.

On March 30th, fifteen pounds of Kleinwanzlebener beet seed was received from

the Department. It was sown April 30th on series H of the station plots, in plots running east and west, rows eighteen inches apart, eleven rows to the plot, plots eight rods long. The plan of the experiment was as follows, the plots numbered from the north.

Plot 1—No treatment.
Plot 2—Spray with Bordeaux mixture at intervals of one week, beginning about July 1st and continued until the weather turns cool in the fall.
Plot 3—Spray with Bordeaux mixture at intervals of two weeks, beginning about July 1st and continue until weather turns cool in the fall.
Plot 4—No treatment.
Plot 5—Nitrate of soda at the rate of 300 lbs. per acre, just before planting.
Plot 6—Nitrate of soda, 150 lbs. per acre, just before planting.
Plot 7—Nitrate of soda, 150 lbs. per acre, just before planting, and a similar application about July 1st.
Plot 8—Nitrate of soda, 150 lbs. per acre, July 1st.
Plot 9—Nitrate of soda, 300 lbs. per acre, July 1st.
Plot 10—No treatment.
Plot 11—Common salt, 200 lbs. per acre, just before planting
Plot 12—Common salt, 300 lbs. per acre, just before planting.
Plot 13—Common salt, 500 lbs. per acre, just before planting.

Following this plan plot 5 received fifteen pounds of nitrate of soda and plots 6 and 7 each seven and five-tenths pounds on April 30th, the fertilizers being well harrowed in before planting. Plot 11 had ten pounds of salt, plot 12 fifteen pounds and plot 13, twenty-five pounds, the salt also being thoroughly harrowed in before the seed was planted.

All plots were drilled in to beet seed April 30th, eighteen pounds of seed per acre.

The season was extremely wet but fortunately this series of plots was on high, well-drained land and did not suffer materially from standing water except plots 5 and 6. Plots 9, 10, 11, and 12 were on rather higher ground with the soil somewhat lighter in color and in physical constitution. The soil varied therefore from a clay loam to a sandy loam. It had corn in 1902, a heavy coat of barnyard manure in the spring of 1902, and had common red clover in 1900 and 1901. It was plowed about seven inches deep and was not subsoiled.

Owing to the wetness of the season the plots had to be hoed frequently to keep the weeds out of the rows. They were hoed May 29, June 16, July 8. They were cultivated May 27, June 25, July 3, July 14, August 7 and August 14, with the horse cultivator and several times with the hand hoe to break the crust.

They were thinned June 5th.

On July 3 plots 7 and 8 each received 7.5 lbs. of nitrate of soda and plot 9, 15 lbs.

The spraying was done as follows, July 6th, plots 2 and 3; July 14th, plot 2; July 27th, plots 2 and 3; August 7th, August 14th, August 21st, and September 5th, plots 2 and 3.

The leaf blight did not appear early and was not bad at any time during the season. It appeared about July 15th, spreading from the south and apparently from some rows of mother beets, four rods south of this series of plots and parallel with them. The spraying seemed to lessen the amount of leaf spot very perceptibly, the sprayed plots being much thriftier in appearance, cleaner and more vigorous than the plots on either side not treated. The plots having nitrate of soda were darker in color, especially the plots having the second application in July. The beets on the plots treated with common salt were yellow in color but very vigorous, the tops being taller than on either of the other plots. They were neither free from leaf blight nor worse afflicted with it than the plots receiving no treatment. The beets were harvested October 20th. The yields are given in the table below with the per cent of sugar estimated from an analysis of ten beets from each plot:

Plot.	Yield per plot. lbs.	Yield per acre, lbs.	Per cent. sugar.	Purity.
1	1,635	32,700	14.5	85.3
2	1,800	36,000	13.6	75.1
3	1,690	33,800	12.8	72
4	1,285	25,700	14	84.8
5	1,200	24,000	15	83.8
6	865	17,300	13.8	77.5
7	1,075	21,500	12.6	76.8
8	1,029	20,580	14.5	86.3
9	1,274	25,480	14	82.6
10	1,376	27,520	14.5	83.8
11	1,326	26,520	16	89.9
12	1,260	25,200	12.1	75.6
13	1,415	28,300	15	89.8

The results, such as are recorded in this table are incapable of reasonable interpretation. It is true that plots 1 and 4 having no treatment yielded less beets than either 2 or 3, but plot 5 having nitrate of soda had a smaller yield than plot 4, having nothing, and plot 6 a still smaller yield than plot 5 or plot 4. The presence of any excess of water on plots 5 and 6 introduces a factor which cannot be estimated and destroys the value of the experiment as far as those plots are concerned. The wide variation in per cent of sugar as stated in the table comes undoubtedly from the fact that the samples taken did not fairly represent the plot rather than from any characteristic difference in the composition of the entire beet crop on the plots.

As soon as it was noted that the leaf blight was spreading from the mother beets, a square rod of beets growing between the series of plots grown in cooperation with the Department and these mother beets was sprayed with Bordeaux mixture and a second square rod measured off for comparison and left untreated. The spraying was repeated, that is, the square rod was sprayed twice. At harvest the beets were counted and weighed on both square rods. The seed had been Jules LeGras sowed May 21st, very late in the season. The beets were therefore small. The 436 beets on the sprayed square rod weighed 242 lbs. The 405 beets on the square rod unsprayed weighed 183 lbs. The chemist reported that the per cent of sugar in the two square rods was identical.

The injury to beets by blight being the removal of the leaves, on the 28th of July all the leaves were removed from a row of beets with a sharp hoe. Within a few days new leaves appeared and, although the tops were smaller than on the rows on either side, by harvest it was hard to distinguish the row which had been thus treated from the remainder of the plot. The 137 beets in the row weighed October 22, when harvested, but 34 lbs., while the 136 beets in the adjoining row, left untreated, weighed 77 lbs. The per cent of sugar in the beets, topped July 28th was 12.6%, while that of the next row was 12.1%. The removal of the leaves in mid-summer is therefore a serious damage to the crop.

A BRIEF REVIEW OF SPECIAL BULLETINS NOS. 24, 25 AND 26.

BY C. D. SMITH, DIRECTOR.

Bulletin 216.

INSECT ENEMIES OF FRUITS IN MICHIGAN
Special Bulletin No. 24, by R. H. Pettit, Entomologist

FUNGOUS DISEASES OF FRUITS IN MICHIGAN
Special Bulletin No. 25, by B. O. Longyear, Botanist

SPRAYING CALENDAR
Special Bulletin No. 26, by L. R. Taft, Horticulturist

The list of persons resident in Michigan, to whom the regular bulletins of the Experiment Station are sent, now includes considerably more than thirty thousand names, compelling the printing of an edition of forty thousand copies of each issue to provide for the necessary reserve. The expense of printing so large a number is a burden. Michigan agriculture is greatly diversified and specialized. This means that bulletins of great value to a given section of the State or to farmers engaged in a given industry would never be read by other farmers not specially interested in the given line of work. It would be manifestly not economical to print bulletins of limited interest for distribution to the whole mailing list. The plan has therefore been adopted of printing a series of special bulletins limiting the number of each edition to a quantity sufficient to meet the probable demand. Most of the earlier numbers of this list are now out of print. A full list of these special bulletins follows:

1. October, 1894, A Year With Bees, R. L. Taylor.
2. (a) Pests of House and Ornamental Plants, G. C. Davis.
2. (b) December, 1894, Millet, A. A. Crozier, abstract of bulletin No. 117
3. October, 1896, Lightning Rods, R. C. Kedzie.
4. November, 1896, The Apple Orchard and Spraying, L. R. Taft.
5. December, 1896, Forecasts of Frosts, R. C. Kedzie.
6. December, 1896, (a) Building Siloes, C. D. Smith.
   (b) Forage Crops, C. D. Smith and A. A. Crozier.
7. January, 1897, San Jose Scale, L. R. Taft.
8. March, 1897, Sugar Beets, C. D Smith and R. C. Kedzie.
9. November, 1898, Farm Accounts, C. D. Smith.
10. January, 1899, Sugar Beets, C. D. Smith.
11. March, 1899, Treatment of Frozen Trees, L. R. Taft.
12. March, 1899, Spraying Calendar, L. R. Taft.
13. December, 1899, Review of Bang's Work With Contagious Abortion, C. E. Marshall.
14. June, 1900, Foul Brood, C. D Smith and J. M. Rankin.
15. March, 1902, Spraying Calendar, L. R. Taft.
16. June, 1902, Aeration of Milk, C. E. Marshall.
17. February, 1903, Mosquitoes and Insects of Year, 1902, R. H. Pettit.
18. March, 1903, Upper Peninsula Sugar Beets, C. D. Smith and L. M. Geismar.
19. May, 1903, Spraying Calendar, L. R. Taft.
20. August, 1903, Report of U. P. Sub-station for Years 1901 and 1902, C. D. Smith and L. M. Geismar.
21. September, 1903, Cheese Problems, John Michels.
22. January, 1904, The Crop of Corn, J. A. Jeffery.
23. January, 1904, A Preliminary Note on the Associative Action of Bacteria in the Souring of Milk and in Other Milk Fermentations, C. E. Marshall.

24. February, 1904, Insects Injurious to Fruits, R. H. Pettit.
25. March, 1904, Fungous Diseases of Fruit, B. O. Longyear.
26. April, 1904, Spraying Calendar, L. R. Taft.
27. May, 1904, Report of South Haven Sub-station, T. A. Farrand.
28. May, 1904, Report of Upper Peninsula Sub-station, L. M. Geismar.
29. May, 1904, The Associative Action of Bacteria in Milk, C. E. Marshall.

Of this list, numbers 1, 3, 6, 12 and 19 are out of print. *As long as the supply lasts, copies of these special bulletins, not out of print, will be sent free to those who apply for them.* Hereafter the number and title of each special bulletin will be given in the first regular bulletin issued after its publication. This bulletin calls attention to special bulletins No. 24, No. 25 and No. 26. All three relate to the enemies of fruit trees in Michigan and suggest remedies. The special bulletins themselves should be in the hands of all farmers owning orchards or other fruit plantations, as it is impossible in the limits of this bulletin to fitly review them or to do more than name some of the most conspicuous diseases and remedies.

THE APPLE.

No fungous disease is reported as doing serious injury to the roots of this tree. The woolly aphis attacks the roots and is treated by a liberal use of tobacco dust or wood ashes, and it is good practice to dip young stock in water at 130° F., kerosene emulsion or tobacco water, before setting out.

The bark of the tree is attacked by the oyster-shell bark-louse, the eccentric scale, the San Jose scale, and the scurfy bark-louse. Various remedies are suggested for these several insect pests in special bulletin No. 24. Professor Pettit does not deem the presence of even the San Jose scale, widely distributed as it is over the State, as a menace sufficiently grave to discourage the progressive fruit grower. Fortunately for him the peril is sufficiently ominous to discourage the half-hearted and incompetent orchardist and to leave the business of apple growing in Michigan in the hands of men of sufficient energy and intelligence to guard their orchards against these pests even at the expense of the frequent sprayings and the bothersome methods which their unwelcome presence makes necessary.

Two borers affect the trunk of the apple and the pear tree, and one of them at least the peach. Professor Pettit suggests eternal vigilance as the price of the early discovery of the depredations of these insects, and the use of a stiff pin, a knife and a wash of strong soap and salsoda, as the best cures.

When we come to the branches of the tree the number of enemies increases. Here we have to deal with the apple scab, canker, black rot, twig blight, fire blight, buffalo tree-hopper and the apple twig-borer. The bulletins under discussion give the latest discoveries concerning these diseases and the best remedies as yet suggested The relation between the rots of the fruit and those peculiar scars upon the bark of the limbs and even of the trunk that used to be called "sun scald" is pointed out and its significance made clear. In the same way the relation of the apple scab to diseases of the leaves and bark, and the importance of ridding the orchard in late fall of diseased fruit, still clinging to the twigs, and of the dead leaves upon the ground, is pointed out. One advantage supposed to be on the side of cover crops as against bare ground was that the former would collect and hold the leaves as well as the snow and thus add manure to the soil as well as provide a covering for the roots. Recent discoveries have shown that the leaves provide a home for certain diseases through the winter, a resting place from which they may issue the following spring to attack the tender leaves, the twigs and even the fruit itself.

The leaves of the apple tree are the most tender and succulent part of its anatomy. These two bulletins point out three fungous diseases and name sixteen species of insects that feed upon them. Fortunately the remedies suggested for fighting these diseases are not great in number nor difficult to manufacture and apply. The insects, for the most part, are poisoned by sprays of paris green, combined with Bordeaux mixture, applied to ward off the fungi.

The fruit is attacked by at least six different species of fungi. Some of them utterly destroy, as the bitter rot and the ripe rot. Others disfigure, as the apple scab, which opens the road for the rots. All of them are avoided by early, frequent and judicious spraying.

Three species of insects attack the fruit, but their depredations are very largely avoided by sprayings with Paris green.

THE PEAR.

What has been said of the apple and its enemies may in a large measure be said of the pear, although this fruit suffers more keenly from diseases that are less hostile to the apple and from others which do not affect the apple at all. The pear requires more care in Michigan than the apple, perhaps even more intelligent, persistent and painstaking attention to ward off the ever present enemies. These bulletins report six insects as affecting the bark, two the trunk, one the branches, seven the leaves, and three the fruit. The fungous diseases attack principally the leaves and fruit, spreading to the newer and more tender twigs.

THE QUINCE.

The quince has some fungous diseases all its own, diseases very injurious, if not fatal to the plant, but of a kind, with two exceptions, yielding readily to judicious spraying.

THE PEACH.

The peach is the fruit which grows to perfection along the west coast of the State and yields a profit even in the interior counties. The immense revenues accruing to Michigan citizens from the sale of peaches is lessened and its very existence threatened by certain serious diseases. Among these, easily the worst, is the yellows, the nature of which is not understood and the remedy not forthcoming. The same is true of the little peach. All that can be done is to educate the eye to detect the first symptoms and the will to destroy every affected tree. The other ills are not past spraying for.

The roots are attacked by a disease allied to the fungi, called crown gall, and by an insect which bores into them; the bark suffers from the dreaded San Jose scale, the English-walnut scale, the peach lecanium, the fruit bark beetle and the eccentric scale; the trunk, from the flat-headed apple tree borer and the divaricate buprestid; the limbs, from the peach twig borer, the tree hopper and the tree cricket; the leaves, from the black peach aphis, the climbing cut worm and the striped peach worm among insects, and the leaf curl, mildew, shot-hole fungus and leaf spot among fungous diseases. The fruit must be protected against the brown rot, the scab, rust, mildew, brown spot, and even against the codling moth and plum curculio.

THE PLUM.

The plum has almost as many enemies as the peach, the same borer attacks the roots, the European fruit scale and the apricot scale its bark, the flat-headed borer its trunk, the shot-hole fungus its leaves and the brown rot its fruit. It has some diseases of its own, like gummosis of the limbs, plum pocket in the fruit and twigs, and the curculio and gouger in the fruit. It suffers, too, with the tent caterpillar, the canker worm, bud moth and rose chafer in its leaves.

THE CHERRY.

The diseases of the cherry are similar to those of the other stone fruits. It has largely the same scale insects on the bark, the same buprestid in the trunk and black knot of the limbs, and the same insect and fungous diseases of the leaves and fruit, with the addition of the cherry fruit fly and the cherry leaf beetle and slug.

THE GRAPE.

The vineyardists must fight against the Phylloxera at the roots, the disease which at one time ruined the vineyards of France and Italy. There is also the root rot, the root borer and the root worm to contend with below ground. The vines are troubled with the cane borer, the cottony maple scale, the apricot scale, the tree cricket, anthracnose and mildew. The leaves suffer from mildew, blight, leaf hoppers, gartered plume moth, hawk moth, leaf roller, rose chafer, flea beetles, the anomala, and spotted pelidnota, and finally the fruit is attacked with black, ripe, bitter and white rots, downy mildew and anthracnose. The remedies for these diseases are not always easy to apply, but are efficient and sufficient in the hands of the intelligent grape grower, while their very difficulty contributes to the profit of the business by keeping out of it over cautious and incompetent men.

These two special bulletins also discuss at length the diseases of the currant, raspberry, blackberry and strawberry and the insects which affect them.

This list of insect enemies and fungous diseases of our important fruits seems long and discouraging, but the bulletins hasten to say that there is one general means of defense against most of them. It is to spray early, thoroughly and often. The spraying materials are at hand in every village drug and grocery store, and methods of preparation and application are fully described in the bulletins themselves.

The spraying calendar simply tabulates, under the name of each fruit, the time to spray and what material to apply, giving also full directions as to the preparation of the spraying combinations.

For any station publication, apply, by postal card or otherwise, to the Secretary, Agricultural College, Mich., giving your own name and address.

Agricultural College, Mich.

May, 1904.

REPORT OF THE UPPER PENINSULA SUB-STATION FOR THE YEARS 1901 AND 1902.

LEO M. GEISMAR, SUPERINTENDENT; CLINTON D. SMITH, DIRECTOR.

Special Bulletin No. 20.

The results of the work accomplished at this Station for the year 1900 are reported in Bulletin 186, Report Michigan Board of Agriculture for 1901, page 149. The station is located at Chatham, Alger county, the southeast quarter of section 28, range 46 north, 21 west and consists of 160 acres of which something less than thirty acres are cleared at the date of this report, January 1, 1903. A house for the superintendent and a barn for storing tools and crops has been built in 1900 and a fence erected about the cleared areas. It was found difficult, however, to exclude the roaming cows belonging to the residents of the near-by village and the deer from the forests bordering the station on all sides. During the years covered by this report, the fence had to be reinforced by additional wires as deer do not seem able to learn the significance of barbs on wires; and new gates were put up in front of the house. The yards were graded about the buildings and the springs along the bases of the terraces were drained through tile.

The amount of land available for crops has been increased north of the house and to the westward but there is an immediate necessity for more land ready for the plow. The size of the plots is too small to allow safe comparisons or calculations of acre yields. To secure cleared land at once the trees have to be blown out with dynamite and the pieces removed by the grub-hoe and team. This is an expensive operation and the funds at the disposal of the station have not allowed an appreciable extension of the workable lands.

It was planned to clear a second forty by cutting down the trees in the usual way and allowing the stumps to rot out, meantime using the field for pasture, but it was found impossible to secure the men for the work and the plan had to be abandoned temporarily.

The orchard of apples, cherries and tree fruits generally is situated north of the house on a terrace, level, but with good air drainage and with soil well adapted to fruit. Between the rows of trees some trials of vegetables have been carried forward as described below. The small fruits are located south of the creek on a terrace high enough to avoid flooding from high water.

WEATHER CONDITIONS.

The season of 1900 had been an exceedingly wet one as reported in Bulletin 186. There was a rainfall of 15.18 inches between the sixth of July and the last day of September.

The year 1901 was, in some respects a repetition of 1900. The rainfall was excessive with extremes of cold and heat. Spring was late in opening with snow on the ground as late as April 24. When the warm weather came it was interrupted by frequent frosts up to the middle of June, the freeze on the night of June 8 killing all small fruit as the currants were nearly full grown, and the strawberries in blossom. There were frosts also on the nights of July 8, September 9, 19 and 30, and October 3. The killing frosts came early in the fall on the fourth and sixth of October.

The first permanent snow fell November 3 although there had been flurries on the fourth and seventeenth of October.

The season of 1902 was quite unlike that of 1901. The spring was early and the autumn late. The snow had practically all disappeared April 9 and vegetation was in active growth by the middle of the month. May temperatures were above the normal, and while several frosts occurred during that month, they caused no damage.

The frost of June 5 did less damage than the steady cool weather which prevailed during the balance of the month. All vegetation started at a rapid pace soon after the first of July, at the close of a prolonged cool period, and remained

thrifty until harvest. The weather of August and early September was ideal and all crops except the most tender vegetables recovered from the set-back given them by the cool June.

The rainfall was neither excessive nor deficient during the growing season. High winds prevailed on several days, those of July 15 and September 10 and 16 being especially damaging to corn and other tall-growing crops.

Perhaps the most salient feature of the season was that only slight damage resulted from heavy frosts and even from such as are usually called killing. The minimum temperature of May 28 is recorded as 26 although where the plants were actually growing it was really 24, yet the damage was insignificant and confined to the blackening of a few potato tops and killing a few fruit blossoms. So the frosts of September 19 and 25 killed the potato and tomato vines but injured less than half of the leaves of the corn.

The first measurable snow fell November 24, 1902, and the ground was frozen to a depth of four inches when permanent snow fell, December third.

The tables below give the mean temperature and the rainfall for each day in the growing season. The record for 1901 includes the months from May to September inclusive, that for 1902, April to October inclusive. The mean temperature for a given day is found by adding together the maximum and minimum for that day and dividing by 2:

MEAN TEMPERATURES.

Date.	April.		May.		June.		July.		August.		September.		October.	
	1901.	1902.	1901	1902.	1901.	1902.	1901.	1902.	1901.	1902.	1901.	1902.	1901.	1902.
1	......	32	60	39	42	67	79	56	60	66	54	54	......	43
2	......	31	47	48	48	67	67	56	61	63	60	58	......	48
3	......	33	44	44	53	53	65	57	58	62	65	56	......	44
4	......	34	54	48	55	42	60	68	57	55	69	44	......	48
5	......	40	58	43	64	46	58	74	62	63	70	51	......	47
6	......	32	64	46	58	56	57	76	66	59	70	61	......	44
7	......	19	60	51	44	53	55	73	66	56	59	61	......	41
8	......	35	43	49	43	50	53	70	56	55	47	59	......	46
9	......	37	55	31	47	60	67	64	51	52	48	47	......	39
10	......	42	57	36	60	52	65	56	59	64	57	53	......	39
11	......	42	49	38	64	57	65	60	56	53	54	53	......	51
12	......	33	46	47	68	47	63	67	68	52	58	41	......	50
13	......	36	38	36	62	54	67	71	70	58	55	43	......	45
14	......	29	39	41	62	52	84	69	67	60	58	50	......	40
15	......	41	50	46	63	70	85	64	62	54	60	55	......	40
16	......	42	58	52	64	57	58	57	63	53	54	52	......	34
17	......	38	60	58	58	53	78	68	71	60	49	52	......	36
18	......	37	53	61	60	63	75	57	68	60	40	48	......	47
19	......	38	48	68	64	51	63	61	65	59	40	44	......	45
20	......	37	49	53	61	50	79	51	66	54	44	48	......	36
21	......	36	55	70	62	37	74	58	67	52	50	57	......	32
22	......	43	51	70	57	47	68	63	71	51	60	57	......	46
23	......	43	49	60	63	50	76	68	63	56	61	52	......	45
24	......	34	40	61	68	57	62	64	59	60	48	47	......	46
25	......	40	40	50	68	55	57	69	66	66	50	43	......	40
26	......	30	49	38	77	50	57	69	66	64	61	55	......	47
27	......	47	48	37	85	52	65	66	62	58	56	61	......	41
28	......	57	43	42	73	50	65	64	73	61	55	54	......	35
29	......	52	45	57	72	52	71	70	74	66	46	55	......	37
30	......	38	59	56	69	54	66	72	58	68	46	49	......	47
31	......	......	53	59	......	......	63	69	49	66	......	......	......	37

RAINFALL.

Date.	April.		May.		June.		July.		August.		September.		October.	
	1901	1902	1901	1902	1901	1902	1901	1902	1901	1902	1901	1902	1901	1902
1			.80		.38			.89		.02		.02		.08
2		.06		.10	.13	.32		.78	*	.47		.02		
3				.05		.47		.02				.28		
4				.30	*		.13	.23				.15		
5					.09		.13	.04						
6		.33		.50	.13	.73	1.00	.04		.05	.59	1.18		.08
7		.30		.12	.24	.02			*	.89				.02
8				.05								.18		.08
9						.23	.1		.56					
10					.09	.07	.02		.12	.08	*	*		
11		.17	.17							.01				
12		.38	*	.16				*	*	.01	.01	.08		
13		.03	*	.11	.53									.98
14						.06		.07	*					.38
15											1.28			.02
16			1.25											
17					.13			.52		.08	.12			.14
18		.01		*						.74	.92	.05		.14
19							*			.02	.09			
20		0.3		.01		.28	.11	.05		.01	.08	.04		.12
21		.30		.01	*	.32	.73							.21
22		.40	.62	.03	.56	.12		.30	.08			.12		.02
23		.23	.42	.40		.01								.13
24			.14		.49	.05	.32		*					.36
25		.32		.03	.50	.62	1.02	.10	*					.10
26		1.79		.21		.02		.37			.29			.21
27				.03	.52		.96				.30			.14
28					*		.73		*		.31	.03		.32
29		.08	.32		.31		.07		.55		1.24			.02
30								.11	.36			.06		.11
31								.01		1.04				.04
Total	......	4.11	3.72	2.11	4.10	3.32	5.32	3.53	1.67	3.42	5.23	2.21	......	3.70

* Trace.

Total—May to September inclusive { 1901=20.04 inches. 1902=14.59 inches.

CEREALS.

FALL WHEAT.

In the fall of 1901, four varieties of winter wheat were sown for comparison of varieties. The raising of winter wheat in the Upper Peninsula has been carried on successfully for so many years that it did not need an experiment of this kind to demonstrate the utility of this cereal. The plots were small,—80 feet wide and 54 feet to 120 feet long. The piece of ground upon which the wheat grew was almost level, slightly inclined to the south. The original timber was heavy, tall and thrifty maple. These trees had been blown out with dynamite during the earlier part of the summer and the subsequent preparation consisted in the removal of the large pieces of rock thrown out by the explosion and grading and filling the holes. The lateral roots of the large trees had been chopped off before the trees themselves were blown out by dynamite. These remaining roots hindered the plowing which was done with a heavy plow, carrying a furrow 12 inches deep. Later the piece was cross-plowed eight inches deep, the roots and stones being removed after each plowing. The ground was thoroughly harrowed with spring-tooth and spike-tooth harrows and the seed was sown broadcast, six pecks to the acre of the Russian and Jones and seven pecks of the Dawson and International No. 6.

The autumn was warm with just sufficient rainfall to promote a good stand. Permanent snow fell November 7th, before the ground froze. The depth of the

snow increased up to January 29th when it was 36 inches deep. From that time it greatly diminished until March 2d when it was 20 inches in depth. This was increased up to March 21st when the depth averaged 44 inches. Thereafter the snow steadily melted away, all traces disappearing on the cultivated ground by April 24th. None of the late May frosts had apparent effect on the plants but the cool night of June 8th blackened a great many leaves. The plants, however, soon recovered. The wheat was sown September 24th; it headed out between the 13th and 16th of June, 1902, the Russian being slightly ahead of the other varieties. The harvesting was done between July 30th and August 3d, thereafter the weather was extremely wet, making the curing exceedingly difficult. The Russian and Jones varieties sprouted badly; sparrows and squirrels visited the fields doing considerable damage, especially with the Russian. All of these difficulties taken together render it difficult to make any statement concerning the relative yields of these varieties that will be of much consequence.

In yield the Dawson led the list, giving approximately 41 bushels per acre. The International came next with a yield of 33.23 bushels per acre. The berry of the International was dark straw color, that of the Jones slightly darker, while the berry of the Dawson was still darker with a slightly reddish cast. The straw of the International is taller than that of the Dawson. The greatest difficulty with the Russian variety was the weak straw, the plot lodged very badly. The Jones' Longberry has a long stiff straw, long heads and large kernels. Throughout the season it was the most promising plot of them all, but for some unaccountable reason it ripened unevenly and much of the grain shelled out before the entire plot was ready to cut. The grain sprouted less than the Russian. The Russian is a red wheat, the other three tested belong to the white class. The Dawson and the International were smooth and the Russian bearded.

SPRING WHEAT.

In 1901 three varieties of spring wheat were tested and in 1902 five varieties. Of those tested in 1901 the Canada Blue Democrat has proven a weak sort. The spikes are tapering and pointed with a rather open head; the straw is medium in quality, the grain dark red in color. The Preston, under normal conditions, may prove a valuable variety. The heads are fairly even, though somewhat tapering toward the top and are compact. The bristles are less numerous than those of the Canada Blue Democrat seldom exceeding 3 inches in length while the heads are often entirely beardless from the base well up to the center. The quality of the straw is fairly coarse, stiff and erect. The grain is light red, kernels hard.

Some "Wild Goose" wheat was sown yielding a heavily bearded head, square, often without taper, compact, never separate, erect, with the bristle bunches forming a head in appearance much like two-rowed barley. The yield of this variety was from 6 to 10½ bushels to the acre.

In 1902 the varieties were Saskatchewan Fife, Velvet Chaff, Minnesota No. 163, Stanley and Nicaragua.

A disease attacked the Nicaragua wheat; fully 75% of the upper half of the heads were dried up at blossoming time. The heads which ripened were perfect with plump kernels, exceedingly hard with the transparency which is characteristic of the Macaroni wheat.

The size of the plots was, necessarily, small. The grain was sown May 14th, except the Stanley and Nicaragua which were sown May 29th; the harvesting occurred July 11th to 12th for the last named varieties and July 16th-19th for the Fife, Velvet Chaff and No. 163. The yield of Nicaragua was very small, that of the Fife 12 bushels per acre while the Velvet Chaff yielded slightly over 19 bushels per acre. Both the other varieties gave 17⅓ bushels As has been stated the season was favorable for all cereal crops, except corn. High winds caused more or less lodging but owing to the comparatively dry weather, rust did but little damage. There was some smut present. The actual yield would have been higher were it not that the wheat had to be threshed by hand and the bundles had to be handled over several times, owing to the lack of storage room, shelling out quite a per cent of the yield. The seed should have been sown earlier.

RYE.

In 1901, eight square rods of spring rye were sown April 27th which yielded at the rate of 28.75 bushels per acre.

BARLEY.

In 1901 none of the plots of barley were larger than one-twentieth of an acre. The season was extremely wet and squirrels and sparrows abundant. These conditions were especially hard on the "Success Barley" which is a beardless sort. The other varieties were reported in the following table, which gives the yield and dates of planting, heading out and harvesting:

Variety.	Date of planting.	Date of heading.	Date of harvest.	Yield per acre, bu.
Oderbrucker	May 15	July 5	August 13	30.00
White Hulless, Northrup & Co	" 17	" 6	" 17	9.58
Canadian Thorp	" 17	" 12	" 17	14.16
Canada Six-row	" 18	" 12	" 24	29.81
Chevalier, 5470	" 25	" 19	Sept. 2	21.04
Swan's Kolskorn	" 25	" 17	August 26	26.45
Princess Korn 5472	" 20	" 21	Sept. 8	9.58
White Vaughan Hulless	" 20	" 14	" 3	8.12
Kwassitzer, 5793	" 21	" 18	" 4	19.6
Success (Beardless)	" 25	" 9	August 17	19.44

The seed for most of these varieties was produced at the Station the year before. All varieties lodged badly although the Swan seemed to have a stiffer straw than the others and ripened slightly earlier. The straw was 2 inches longer than the average of the other varieties but the heads were covered with the usual objectionable beards.

In 1902 there were six varieties The Manchuria and Canada were six-rowed. The variety No. 5799 is bearded and very short; the straw is much taller than with the ordinary varieties, the seed heads loose and very long and the kernels elongated often nearly a half inch in length. The variety seemed to have the same disease that affected the Nicaragua wheat as fully 25% of the heads were withered for half their length. The Manchuria variety gave the largest yield,—41.66 bushels per acre. This was followed by the Oderbrucker which yielded 30.83 bushels per acre. This variety again, as the year before, taking lead, except the variety named above, tested for the first time in 1902. Canada Six-rowed and French Chevalier follow next with 25.5 bushels per acre to their credit, the Canadian Thorp being one bushel per acre behind them.

OATS.

The oat plots in 1901 were as in the case of the other cereals too small to allow a safe calculation of yield per acre, moreover the Silver Mine variety had to be sown in a part of the Station grounds somewhat different from the other plots, making it impossible to compare the yields. The Black Beauty will prove a heavy yielder in the Upper Peninsula under favorable circumstances; it stood up better than any other variety except the Daubeny, and it was only the rains of late August that succeeded in lodging any of the plots, and moreover, it was the only variety, except the Daubeny, which weighed more than 32 pounds to the bushel. It must be remembered that with the oats, as with the other cereals, the repeated handling of the bundles in the wet season of 1901 in the attempt to dry them, shelled out no inconsiderable quantity of grain and seriously affected all varieties, the later ones much more than those harvested earlier. Both the Black Beauty and the Daubeny gave yields over 42 bushels per acre. The Silver Mine came next with 33.33 bushels per acre. The Rhode Island Rust Proof was next with 32.34 bushels per acre; the Lincoln, 30.62 bushels per acre, and the Columbus, Dupauper, Scottish Chief, Big Four, Michigan Wonder, American Banner and Black Russian with yields between 20 and 25 bushels per acre.

Again in 1902, among the varieties of oats, the good stand, thrifty appearance and well filled heads of Black Beauty remained conspicuous throughout the entire season. In measured yield Columbus surpassed the Black Beauty but this fact is

partly to be ascribed to the frequent handling which the bundles of the Black Beauty received and to the further fact that the yield of the Black Beauty was stored out of doors which made the threshing with the flail more difficult and less complete. The recorded yields per acre of the varieties of oats in 1902 were as follows.

	Bushels.
The Columbus	63.75
Black Beauty	53.75
Lincoln	52.50
American Banner	48.75
Dupauper	37.50

The season of 1902 was evidently much more favorable than that of 1901 for oats and a good yield resulted with all varieties. The Station is attempting to select those sorts which will best resist wet weather, rust and smut, and will be most apt to give good yields under the conditions which exist on Upper Peninsula farms.

CORN.

The season of 1901 was peculiarly unfavorable to corn, owing to the frequent frosts in May. It was unwise to plant until after the first of June. Thereafter the corn grew rapidly up to the last of August when all varieties were in the glazing stage. The frosts of September did but little injury to this crop; the fall army worm made its appearance but not until late in September and then the depredations were confined to the work of an occasional larva on a small soft ear.

Among the numerous varieties tested some are worthy of special mention. Considering the lateness of planting, the Gilman made an enviable record; the kernels are good size, the cob medium, with strong stalks and broad and abundant leaves. The Dent variety, Wernich's Sweet Pearl seemed the most desirable and showed its superiority from almost the beginning of the season. With proper selection this variety can be much improved as to size of cob and number of rows of kernels. Nearly all the varieties were planted between rows of fruit trees, in hills four feet apart each way and the plots cultivated thoroughly through the season. None of the varieties ripened a very large proportion of the ears and, consequently, reports of yields are out of the question. The work of the Station is to be directed toward the selection not alone of varieties but of strains of each variety which will mature in the latitude of the Station.

Notwithstanding the much more favorable season of 1902, none of the varieties of corn ripened much better than in the preceding unfavorable year. The cool weather in June accounted for this lack of maturity; the season itself between frosts was long enough to ripen any of the sorts since there was no frost damaging to corn between June 5th and September 19th. All varieties reached the glazing stage before September 19th and many ears partly ripened. The Minnesota King, a yellow Dent, was the nearest ripe of any of the varieties tested. One-half of the kernels were well dented The next nearest ripe was the Yellow Dent, name unknown, but coming from Milford, Michigan, the seed having been furnished by Mr. F. W. Potts of that place, who stated that he had been improving the variety for several years by careful selection. It is, undoubtedly, an improvement on the Dakota Yellow Dent with a more abundant and larger foliage and larger and longer kernels, smaller cob and taller stalk, averaging here 10¼ feet in height. To test the vitality of seed ripened at this Station during the wet season of 1901, one-half of the plots of Longfellow and Triumph were planted with such seed, fresh seed being used for the other halves. The corn tasselled at the same time in both halves of each plot and no difference could be observed between the home grown and foreign grown seed at any time during the season.

Of the sweet corn varieties none ripened in 1902 and only one arrived at the edible stage, namely, Oakview Early Market; planted May 23d, edible September 12th; ears 8 inches long, 12 rows, kernels large and fairly sweet, stalks averaging 4 feet.

FORAGE PLANTS.

ALFALFA.

The seed sown in 1901 was mixed with weed seed. None of the weeds became troublesome, except two heretofore unknown, and hence not enumerated in Bulletin 186; one is the common weed known as Ribwort or Narrow Leaved Plantain, which was liberally sprinkled over every plot. The other was found only on the plot of Turkestan Alfalfa and was the common pest known as Dodder, a parasitic plant developing numerous orange-colored threads which twine around the stem of the alfalfa and kill it. The remedy for the Dodder is to mow the alfalfa before the seeds of the Dodder mature or if not discovered in time to do that, to mow and burn on the ground to prevent scattering the seeds over new territory.

All the varieties sown answered to the description of alfalfa, the various seeds being either of foreign or domestic origin. No distinction as to growth or hardiness could be observed. All were approximately of the same height when harvested and the difference in yield could not serve as a safe basis of comparing the varieties, the plots being too small. Turkestan Alfalfa differs but slightly from the other varieties; the velvety feeling of the leaves caused by minute hairs is perhaps more prominent in this variety and this ought to be a point in its favor as far as hardiness is concerned.

The distinction between Sand Lucern and the other varieties is too small to be noticed by the average observer. It is said to be superior to the others on light sandy soil and to be killed by stagnant water; it is claimed for it that it will stand cold weather better than common alfalfa. The growth in 1901 of this sort was so satisfactory that two crops might have been safely removed had the autumn been as favorable as that of the normal season. As it was, the weather conditions were at their worst in October and the plots were left undisturbed, although, at that time the crop had made a growth of 12 to 18 inches. The weather at the time of harvesting the previous cuttings of the season was very favorable. Usually the plots were mowed in the morning as soon as the dew was off, the swath left until the leaves were wilted then raked in windrows. On a few plots the hay was sufficiently cured to be hauled under cover the same day while that on others was left in small cocks during most of the following day. The hay was in prime condition, keeping its bright green color and holding its leaves well when handled. Its fine aroma could be easily distinguished long after other crops were stored in the same barn. The hay was harvested when the plots were slightly more than one-third in blossom.

Some plots of alfalfa, one-half rod in width, were sown between the fruit trees to plow under the following spring; following the plan of "sowing a leguminous plot to enrich the soil by the decay of the crop when plowed under." It must be remembered, however, that alfalfa, while being very beneficial to a young orchard if handled correctly, is worse than weeds if left longer than one year among trees set close together.

The alfalfa seed sown was of the Turkestan, French and German origin and the Sand Lucern from the importation of the Wernich Seed Company. The Sand Lucern gave a slightly larger yield. They were all sown May 25th, blossomed from the first to the third of August and were cut August 15th to August 17th, the French Alfalfa being at that time 31 inches high and the German and Sand Lucern 34 inches These plots of alfalfa were observed during the season of 1902. They were not fully established even during the second year, but their behavior and thriftiness at this early age makes it safe to recommend alfalfa as one of the most suitable and valuable forage crops for the millions of acres of limestone soil of the Upper Peninsula; being a soil replenisher, alfalfa should by all means take the place of timothy which is relatively a soil robber. This advice is driven home by the fact that the annual yield of hay from an alfalfa field is sometimes three and five times as great as from a similar field of timothy. The yields of well cured hay for this, the second season are shown in the following table which also gives the estimated yield per acre, each plot containing six square rods:

Time cutting.	Turkestan. Lbs.	French. Lbis	German. Lbs.	American. Lbs.
July 8	54	68	136	97
August 11	40	60	100	70
September 22	24	46	68	51
Total	118	174	304	218
Per acre	3,146	4,640	8,106	5,813

The less satisfactory yields of the Turkestan and French varieties are unquestionably due to the poor location of the plots and not to inferiority of the varieties themselves. The Turkestan is nearest and the French next nearest to the side of a steep hill from which most of the top soil had been removed in grading and leveling about the house. Furthermore a careful investigation of the roots of numerous plants failed to reveal the presence of the tubercles so essential to the best development of leguminous crops. It should be recorded also that a thin coat of well rotted stable manure was applied to alfalfa plots in the fall of 1902.

CRIMSON CLOVER.

The seed was sown in May, 1901, and notwithstanding some injury by the weather at the beginning of June and the frost on the 8th of that month yet by the middle of July the ground was densely covered; the plants nearly even and obtaining a height of 36 inches by the middle of August. The difficulty in curing the hay complained of elsewhere was experienced at this Station. Cut September 4th it was not sufficiently cured on the 6th to haul. A shower made it necessary to spread it out again leaving it one day in small heaps and two days in large ones. Although in apparently prime condition when finally hauled to the barn, it was found to be moldy less than two weeks after. The root system of crimson clover differs materially from that of the medium red; the roots being short and spreading close to the surface. That it ought to succeed in this latitude as far as hardiness is concerned was shown by the fact that the plants made a good growth during the balance of the season and a number of new blossoms could be seen before the ground disappeared under the November snows. Up to November 13th the thermometer had repeatedly rgistered 17° and 18° yet when on the latter date the average depth of snow reached 8 inches there could still be seen an occasional sprig and bright crimson blossom. The harvested plot planted May 25th covered a surface of 2,066 feet. The plants blossomed August 16th and were cut September 4th, giving a yield of, approximately, 4,110 pounds per acre.

Sown May 1st, 1902, on a plot rather poorer in quality than the plots upon which the other varieties of clover were sown, it suffered from the cool weather of June. It was harvested August 11th and yielded 2,533 pounds of well cured hay per acre.

SANFOIN OR ESPARSETTE.

This variety of clover is extensively grown in Europe. It is somewhat coarser than June clover though fully as hardy; its showy appearance when in full blossom is nearly as conspicuous as that of crimson clover. The stand was thin owing to poor seed and the vacant spaces were reseeded early in August. It seemed to grow well but a poor stand made harvesting impossible.

FIELD PEAS.

In 1901 four varieties of field peas were tested. The squirrels damaged the plots, shelling a great many pods and carrying away not a few. The White Wonder is a good quick-ripening variety, the peas moderate in size and the pods well filled For early ripening the Early Britain is fully as good, slightly angular and of a

reddish drab color. Prussian Blue is a fine variety and with Canada Beauty offers two rank growing sorts with vines averaging 11 feet in length. The vines continued to grow and blossom late in the season and thus interfered with the curing of the lower ripe pods. The Canada Beauty is slower in ripening owing to the extremely large size of the peas. Both varieties ought to be good for forage on account of their large yield of straw. They were not cut for forage, however, but were allowed to mature and were harvested, White Wonder and Early Britain September 2d and Prussian Blue and Canada Beauty September 14th to 16th. The yields were from 29 to 38 bushels of ripe peas per acre.

In 1902 along with the Imperial Blue and Canada Beauty three other sorts of peas, namely, the Black Eyed Marrowfat, the Scottish and the Egyptian Mummy were tested. They all yielded abundant weight of straw due to the unusual length of the vines, for these reasons it has been somewhat difficult to cure the crop heretofore and the Scottish variety was tested with the expectation that it would prove an exception to the general rule. The expectation was not fully realized although the vines averaged 8½ feet in length while those of the other varieties averaged 10½ feet While the favorable climate may partially account for such rank growth, the main reason seems to be that every plant was found at harvest time to have upon its roots numbers of characteristic tubercles all of a large size and many exceeding ¾ inches in diameter. The function of these tubercles is well known and through the micro-organisms resident in these nodules is the plant furnished with abundance of nitrogenous food. While this excess of vegetation may make the crop difficult to cure, the farmer of the Upper Peninsula can rely upon this crop and barley for food for his stock while he bides the time when the removal of the forest will afford the proper climatic conditions for corn and the wise selection of the seed will demonstrate the proper variety to make the growing of that truly American forage crop possible and profitable in this region.

Of the five sorts tested, the Marrowfat, Canada Beauty and Prussian Blue yielded 41 bushels to the acre. The Scottish and Egyptian Mummy were planted two weeks later than the other sorts which may account for their lesser yields, 22.66 and 34.66 bushels per acre respectively. Of the straw the Black Eyed Marrowfat returned 4,100 pounds, the Scottish 3,780 pounds per acre.

VETCHES.

Two varieties of spring vetch and one of winter vetch were tested in 1901. Vetches should be sown with rye, oats, barley or spring wheat in order to allow the plants to climb, the vetches having stems which end in tendrils. Sown alone as they were at the Station, they were difficult to mow. No matter how planted the question of curing the hay will always remain a difficult one The winter vetch covers the ground more rapidly than spring vetch, but like the latter is well adapted to northern latitudes and to light soils. The vetches were cut when past full blossoming stage and when the seed and pod were fully formed. Of cured hay the winter vetch gave per acre approximately 4,373 pounds, while the spring vetch yielded slightly less than 3,000 pounds per acre. Both were sown May 25th. The spring vetch blossomed July 22d and was cut August 14th, the length of vines being 36 inches. The winter vetch did not blossom until August 5th and was harvested August 31st, the length of the vines being 72 inches.

In 1902 the spring vetch was tested mainly for the purpose of finding out whether the seed would successfully ripen in the latitude of the Station. Seed was broadcasted May 30th. The plants began to blossom July 11th and were harvested September 15th yielding seed at the rate of 920 pounds per acre with 5,400 pounds of straw. It would seem, therefore, that spring vetch ought to prove a profitable crop; first, because it is a legume gathering part of its nitrogen from the air, second, because it produces a good yield of high priced seed and third, because of the high feeding value of the hay. The main objections to the vetch are the danger of becoming a weed and the trailing habit making the curing of the hay difficult and, if the season is bad, impossible. For this reason some cereal like oats or wheat should be grown with the vetches. On May 30th one plot was sown with clear vetch and the second plot with a mixture of one-fourth spring wheat to three-quarters vetch. On the wheat and vetch plot the blossoms appeared July 8th, while on the plot of clover they were not apparent until July 13th. Both plots were cut August 11th and although the yield of wheat and vetch was nearly 53% larger the hay cured in a much shorter time. The yields of hay were, per acre, 3,400 pounds for the clear vetch and 5,200 pounds for the wheat and vetch.

SOJA BEANS AND COW PEAS.

Soja beans or soy beans as they are variously called have long been cultivated in the south where they are cut and baled as hay. Although but recently introduced, the nature of the stem and leaves strongly indicates that this forage plant will quickly adapt itself to this region. The acclimation of cow peas will be decidedly slower owing to the more glabrous nature of the leaves and the softer structure of the entire plant. Both crops were sown between rows of fruit trees, the seed drilled in by hand. The rows were 18 inches apart for frequent cultivation during the early part of the season as long as the size of the plant would permit. The growth of the Soja beans is slow but even and steady and the plants seemed unaffected by the abnormal weather condition although at their best during the hotter and drier portions of July and August The early September frost did not materially damage them, although by the end of the month approximately one-third of the top leaves were browned by the severe frosts. The seed sprouted quickly and the middle of July found the ground well covered. By the first of September the plants had reached the uniform height of 36 inches and the subsequent growth was trifling. A few ripened their seeds. The seed of the cow peas sprouted as quickly as that of the Soja beans but the growth was much slower and the plants were far from sheltering the ground by the middle of July. The plot began to suffer from the extreme heat of that month and became affected by what closely resembled the anthracnose of the bean. Most of the leaves became spotted and dropped off. Cultivation and cooler weather gave the plant a new start and by the middle of August all were flourishing, even those from which nearly all the leaves had dropped. By the end of August the plants had made a dense mat over the ground and the buds were in an advanced stage of development. The plants maintained an average height of 32 inches, although none had blossomed on September 9th when a slight frost seriously damaged the early plot and a second slight frost on September 19th killed the entire plot.

LENTILS.

A plot of lentils was tried in 1902. The lentil is a small branching plant, with delicate pea-like leaves. The seed is round, very flat and convex on both sides. The small white blossoms are followed by flat pods each containing two seeds either yellow or reddish according to the variety. They are eaten only when fully ripe, the reddish colored being the smaller, but the better flavored of the two. Like the pea or bean, the lentil is a legume and worthy of cultivation for its nitrogen-gathering power.

Lentils in this country are seldom seen in cultivation unless perhaps in one or two southern states having a fair proportion of its population of Spanish or Mexican origin. They are eaten principally by our foreign population, being more or less extensively grown in many European and Asiatic countries and being perhaps better known in ancient times than any other legume. Since lentils sell for six cents per pound and over, they would seem to be a profitable crop to raise. A plot 1x4 rods was planted April 30th; the seed being broadcasted and harrowed in. The growth was unchecked by the cool June weather and the blossoms appeared July 2d. They were harvested September 16th, the yield being 29 pounds or 1,160 pounds per acre, while the straw yielded 94 pounds or 3,760 pounds per acre.

JUNE CLOVER.

Sown May 1st, 1902. This, as did all other clovers, made a very heavy stand. Nearly all the weeds except smart weed were choked out. It was cut August 11th when nearly in full bloom and yielded at the rate of something over two tons of dried hay per acre.

ALSIKE CLOVER.

Also planted May 1st and appears to be better adapted to low ground; a higher yield must be ascribed to the low well-drained soil upon which the plot was located. The yield was 3,066 pounds per acre.

TIMOTHY.

The soil where the timothy seed was sown was unfavorable for the growth of grasses. The grass grew well, however, and gave us two crops during the season.

The heads appeared July 18th and the crop was harvested August 5th. Before the end of September the timothy had again headed out. Because of the poor quality of soil this second crop was not harvested.

ORCHARD GRASS.

At the Station, as elsewhere, the growth of this grass was in bunches showing the necessity of mixing it with other grasses. It should be sown on high well drained soil.

RED TOP.

This is another pasture grass better adapted to low ground, however, than orchard grass. The plot grew well during the season and gave a yield of 800 pounds of dried hay per acre.

BROME GRASS (BROMUS INERMIS).

The seed was sown in the spring of 1901 and as reported was upon soil unfit for any grass crop.

In the spring of 1902 as early as the 24th of March, when the average depth of snow was still 2 inches the grass had made a new growth, fully 3 inches above the snow line. This growth kept on unchecked regardless of frost and the plant headed out June 2d. At harvest July 7th there was a yield of 3,285 pounds of hay per acre. By the middle of September the grass had again headed at the uniform height of 16 inches but was left on the ground as a mulch.

GIANT SPURRY.

A very hardy and rank growing forage plant, apt to become a weed. Its name indicates that it scatters its seeds widely. It is cultivated in Europe for sheep and is especially adapted to sandy soils. It yielded on the two cuttings of July 28th and September 10th enough to indicate an approximate crop of 3½ tons per acre.

SORGHUM.

"Amber Cane" variety was used for the test of 1901. The seed was drilled in by hand, quite thick, about an inch apart, in rows 18 inches apart. Level culture was given and kept up as for corn and until the plants were two feet high. The cane stood the wet weather fully as well as any variety of corn although the leaves were slightly affected by rust. The plant was not greatly affected by frost except that the seed did not ripen; the juice remained sweet until after the crop was harvested. An attempt was made to cure the canes for fodder by leaving them in small and later in large shocks. Two weeks after cutting, the juice still ran in streams when the canes were twisted and the canes had not materially cured when the crop was hauled to the barns.

MILLET.

One plot was planted between the fruit trees in 1901, the seed being the common barnyard millet. A splendid stand was obtained with a rank and rapid growth throughout the season. It was sown on the 12th of June, headed out the 6th of August, and was harvested September 14th. The yields were interfered with by hordes of sparrows feeding upon the seed, both before and after cutting. The curing was interrupted by several rainy days and the hay had to be spread out repeatedly but was in good condition when finally hauled under cover and weighed, giving a yield so large as to indicate something like 4 tons per acre of cured hay.

DWARF ESSEX RAPE.

The seed was sown June 21st. Most of the plants were 38 inches high by the middle of September and remained unhurt by frost until late in October.

The snow in 1902 did not come as early in the season as usual and the ground froze at the surface. Some of the rape plants were left standing over winter and were still alive in the spring of 1903.

MISCELLANEOUS FIELD CROPS.

HEMP.

The seed was planted June 4th. The growth was rapid, the staminate plants were in blossom September 8th and the pistilate ripened their seed early in October. Specimen plants measured 11 feet 8 inches, a height seldom obtained in Kentucky. That the natural conditions in this region should be as well, if not better, adapted to hemp culture than those in the southern states does not follow of course from the result of this first test. What is shown is the hardiness of the hemp crop. Doctor A. C. Lane, the State Geologist, in Bulletin No. 186 of this Station, says:

"As we approach Lake Michigan we get into the belt of the Trenton Limestone and the Cincinnati beds, the very same formations which make famous and fertile the blue grass region of Kentucky."

No attempt was made to ascertain the yield of seed as a band of goldfinches discovered it as soon as it began to ripen.

FLAX.

Was planted June 4th, 1902; averaged 3 feet when fully developed; the seed ripened September 8th. The growth of the crop and its condition in the fall showed that this part of the state is well adapted to the growing of flax.

VEGETABLES AND ROOT CROPS.

POTATOES.

All varieties were planted in 1901 in rows 4 feet apart, 18 inches between hills; one piece with 2 to 4 eyes for each hill. The potatoes were not up on June 8th when the frost occurred. They made a rapid growth which remained unchecked until late in August when the blight, induced by excessive rains, made its appearance and continued until the close of the season. The potato bettles were out in full force, coming early and staying late and seemed to increase rather than decrease with each spraying. An application of Bordeaux mixture with Paris Green was given nearly every week and no sign of early blight could be noticed. The potato bettle "tachinid," described by Professor Pettit in Bulletin No. 186 was entirely absent this season. Not a fly could be found nor a potato bettle covered with eggs. For some unaccountable reason the north side of the field was more affected by late blight and potato bettles. Walter Raleigh promised to be one of the best and most profitable sorts for this latitude, especially when considering its behavior and habit of growth.

The potatoes are medium to large, often exceeding two pounds for single specimens, none of which were found to be hollow. As could be expected, many varieties forced the tubers out of the ground, the plowing not having been sufficiently deep for successful potato culture. To this, although having the largest tubers, Sir Walter Raleigh was an exception. The vines are strong, dark green, 2 to 2½ feet long, shading the ground just sufficiently and still enough spreading for the proper ripening of the crop. The shape is what may be termed the *proper market* shape, the same being found in Carman No. 3 and to a considerable extent in Delaware. While all three varieties have perfect specimens, by far the largest percentage is represented in Sir Walter Raleigh.

The Delaware, of all the varieties tested, is the most desirable. The vines are light green, medium strong, 2½ feet long, very bushy and completely covering the hills. Skin about the same as that of Sir Walter Raleigh, perhaps a shade whiter, slightly more netted, and the eyes are a trifle more sunken. The flesh of both varieties is white, fine grained and quite solid.

Carman No. 3 answers more generally to the Sir Walter Raleigh description but the tubers are not quite as flat, and it is inclined to extend its season longer than the other variety.

Six Weeks was the second in ripening, the vines dying off rapidly after September 10, and the potatoes being thoroughly ripe on September 17. Skin white, netted. Tubers round to ovate, flattened, medium size, inclined to be knotty, with eyes quite shallow. Flesh dark white, coarse but dry.

Honeoye Rose was next to Six Weeks in ripening. Skin light pink, fine. Flesh white, fine grained and dry. Small size of tubers perhaps owing to late blight due to location of plot.

Pingree was the first variety in ripening, and for quality was the best. Skin white and smooth. Flesh white, fine and very dry.

Irish Cobbler is the smallest in size as well as lowest in yield. Flesh white and firm, fairly dry.

Thoroughbred is a desirable variety for size, yield and quality. Flesh white, coarse and fairly dry.

Pinkeye is an attractive looking variety, the tubers being white skinned and often red splashed in spots. Flesh fine, but not dry.

In the table below the date of ripeness as indicated, is the date upon which a large percentage of the vines were dead and the potatoes ripe. The varieties given as ripe September 20 are those the vines of which were ripening previously and being slightly injured by the frost of the previous night, the potatoes upon inspection were found quite ripe. Those marked as ripe October 5, are those the vines of which were killed by the frost of the previous night and of these five varieties Sir Walter Raleigh and Rose of Erin were then the ripest, being followed in degree of ripeness by Delaware, Northern Beauty and Carman No. 3 in the order named:

Variety.	Size of plot.	Time of planting.	Time of blossoming.	Time of ripening.	Total yield.	Yield of small potatoes.	Total yield per acre.	Yield per acre merchantable size.
	Rods.				Bu.	Bu.	Bu.	Bu.
Carman No. 3	1½x45½	May 31	August 6	Oct. 5	113¾	13	266.66	236.19
Boyee	¾x3	June 1	Aug. 4	Sept. 15	3	½	213 33	177.77
Harrington Peer	¾x8	June 1	Aug. 5	Sept. 20	6¾	¾	180 00	160.00
Honeoye Rose	¾x8	June 1	Aug. 4	Sept. 18	5	1	133.33	106 66
Six Weeks	¾x8	June 1	Aug. 2	Sept. 15	5	¾	133.33	113.33
Thoroughbred	¾x8	June 3	Aug. 6	Sept. 20	9½	½	253 33	240.00
Snowflake and Blush	¾x17	June 3	Aug. 5	Sept. 20	10½	3	131.76	94.11
Delaware	¾x8	June 3	Aug. 2	Oct. 5	12½	1	333.33	306 66
Pinkeye	¾x8	June 3	Aug. 6	Sept. 20	8¼	1¾	220.00	173 33
Pingree	¾x8	June 3	Aug. 3	Sept. 5	7½	¾	200.00	180.00
Rose of Erin	¾x8	June 3	Aug. 2	Oct. 5	11	½	293 33	280.00
Sir Walter Raliegh	1½x41	June 5	Aug. 10	Oct. 5	120¼	6	312.84	297 23
Pride of Michigan	¾x8	June 6	Aug. 8	Sept. 15	7	1	186.66	160.00
Hurst	¾x8	June 6	Aug. 10	Sept. 15	5¾	¾	153 33	133.33
Irish Cobbler	¾x8	June 6	Aug. 5	Sept. 15	4¼	¾	113 33	93.33
Northern Beauty	1½x4	June 6	Aug. 10	Oct. 5	5¾	1¼	153.33	120.00

In 1902 all potatoes were planted June 4 to 10, the plots being laid out between the rows of fruit trees as during the preceding season, and three rows 4 feet apart being planted between each row of trees, thus leaving four feet for cultivation on each side of the tree row. Planting was done by means of the Acme hand planter, the hills being 18 inches apart in the row and a single seed piece with 2-3 eyes was used for each hill. The ground was plowed soon after the middle of April, then harrowed once each week until planting time. The soil was thus left in good tilth, and the almost total absence of weeds during the rest of the season made subsequent work an easy task. Level cultivation was given throughout the season and at least once every ten days until the length of the vines interfered. Early cultivations were deep, and done with the one-horse spring-tooth cultivator, while shallow cultivations were subsequently given with the Planet Jr. horse cultivator. As deep plowing was not deemed advisable in the orchard,

a late hoeing was given, mainly for the purpose of bringing some dirt against the hills and thus prevent the exposure of some tubers made possible through shallow plowing. Potato bugs came in large numbers early in the season and spraying was started soon after the potatoes were up, white arsenic and Bordeaux mixture being used to exterminate the bugs and at the same time guard against early or late blight. Bugs proved persistent and not all were destroyed after four sprayings had been given. Though blight was prevalent elsewhere, as could be seen from a plot purposely left unsprayed, the vines were kept immune until August 10 when spraying was stopped owing to an accident to the spray pump and the inability to get it repaired until too late in the season. Further growth was seriously checked thereafter, many vines were dead before the advent of the September frost and, as a consequence, the yield of all varieties was materially reduced. The varieties most resistent to blight were Sir Walter Raleigh, Rose of Erin, Northlight and Wonder of the World in the order named. All the vines were badly damaged by the frost of September 19 and killed by the frost of September 25. All varieties were quite ripe when harvested. The following varieties were tested for the first time:

Rosy Morn. Vines 20 inches, small, light green. Tubers round, oblong and slightly flattened. Skin pinkish white. Eyes broad, open, of medium depth, often with sharp prominent lip, and pink color. Flesh white, fine grained and dry.

Norther. Vines 20 inches, slender, dark green. Tubers round oval, slightly oblong. Skin white somewhat russeted. Eyes open, broad and shallow with pink markings. Flesh white, dry and of good quality.

Dew Drop. Vines 20 inches, light green, strong and spreading. Eyes narrow and irregular, running from very shallow to medium deep. Skin pink and smooth. Tubers oblong, oval and flattened, often pointed at seed end. Flesh white, coarse, but fairly dry when cooked.

Wonder of the World. From seed kindly furnished by S. T. Simpson of Bruce's Crossing (Mich.). Vines 26 inches, dark green, vigorous and spreading. Tubers oblong, slightly oval and flattened. Eyes narrow, very open, shallow. Skin slightly russeted, white and marbled with light pink. Flesh white, fine grained, dry and of excellent quality. Very prolific and an attractive market variety.

Northlight, a new variety introduced by the Wernich Seed Co. of Milwaukee (Wis.), who kindly furnished the seed. Vines 28 inches, stout, spreading, dark green. Tubers oblong, broad, flattened. Skin pink and finely netted. Eyes, narrow and very shallow. Flesh white, coarse but dry and of good flavor. A good yielder and tubers mostly of marketable size.

Varieties of potatoes planted in 1902:

Variety.	Date of planting.	Date of blossoming.	Yield per acre in bushels.		
			Large.	Small.	Total.
Pingree	May 30	July 18	122 2-9	8 8-9	131 1-9
Six Weeks	June 9	July 29	113 1-3	13 1-3	126 2-3
Bovee	June 5	July 25	113 1-3	20	133 1-3
Rosy Morn	June 9	July 29	80	13 1-3	93 1-3
Dew Drop	June 9	July 29	74 2-3	16	90 2-3
Irish Cobbler	June 7	Aug. 3	93 1-3	13 1-3	106 2-3
Northern	June 9	July 31	62 2-9	13 1-3	75 5-9
Honeoye Rose	June 5	July 28	133 1-3	6 2-3	140
Harrington Peer	June 5	July 25	112	5 1-3	117 1-3
Pinkeye	June 7	July 28	115 5-9	17 7-9	133 1-3
Hurst	June 7	July 29	117 1-3	10 2-3	128
Thoroughbred	June 5	July 29	112	10 2-3	122 2-3
Pride of Michigan	June 10	July 30	111 1-9	11 1-9	122 2-9
Delaware	June 5	July 25	142 2-9	8 8-9	151 1-9
Northern Beauty	June 5	July 25	146 2-3	13 1-3	160
Rose of Erin	June 7	July 26	215 5-9	6 2-3	222 2-9
Sir Walter Raleigh	June 9	Aug. 12	215 5-9	11 1-9	226 2-3
Wonder of the World	June 4	July 27	186 2-3	6 2-3	193 1-3
Northlight	June 4	Aug. 6	177 7-9	7 1-9	184 8-9

AN EXPERIMENT IN POTATO CULTURE.

It has long since been proven that northern grown seeds are the best. The demand for northern grown seed potatoes is increasing more rapidly than that for seeds, owing to the fact that the potato, especially for home use, is more generally cultivated than any other crop, and because potatoes when ripened in the southern states, are less fit for seed.

The limestone soils of this region, together with its cool atmosphere, its heavy dews and otherwise always abundant moisture made secure through its geographical position, ought to make this a supply center for choice potatoes, second to none.

Until the advantages of a new region become a matter of general knowledge, its producers must search for a market, when local demand is supplied. For some time, therefore, the pioneer farmer in this region will be confronted with the usual problems relating to the production besides those concerning the disposition of the potato crop. The principal questions in regard to the economical production of the crop have been exhaustively treated by most experiment stations, and it is not likely that further experiments along these lines will do more than substantiate the correctness of former conclusions.

A careful observation of the general methods employed in the principal potato growing regions, leads to the assumption that many now northern grown potatoes will sooner or later find disfavor with the southern consumer. It may be confidently asserted that over one-half of the potatoes put on the market in recent years are in an unripe condition. Not infrequently, late potatoes can be seen, but little better than out of season southern potatoes, bought in a limited way as a fad and not for their food value, since they practically have none from a nutritive standpoint. The general tendency is to grow potatoes regardless of rotation of crops or other sound farming methods, and the consequence is a constantly diminishing yield which ceases to be profitable. Rather than to apply correct farming principles, the average farmer is beginning to reduce the cost of production at the expense of quality, by planting too late in order to "cheat potato bugs" as he puts it.

Were it safe to presume that the average consumer will always be satisfied with potatoes raised under such conditions, then the question of shorter seasons will never affect the farmer in this region, when trying to market his surplus potato crop. It should be, and is, however, the aim of experiment stations to teach not only what to raise and how to raise it, but how to satisfy the consumer. To produce and market the best has been found essential in trying to win back distant markets for dairy products, and in the profitable disposition of fruit crops. It cannot be claimed that the best in potatoes is an unripe potato no more than it is contended that unripe peaches are best because they cannot be profitably shipped in any other condition. Since the demand for better ripened potatoes is therefore likely to become more general, and since it would then mean a longer season between the time of planting and harvesting, it is liable to become of importance whether the season in this region will ultimately be considered of sufficient length for thoroughly ripening all varieties of potatoes. Though it is a well established fact that hardy plants will grow faster and mature quicker in northern regions, and that this is due either to some peculiar atmospherical influences, or to the greater length of days during the growing season; and though all varieties of potatoes heretofore tested at this Station have been as ripe at harvesting time as the average potatoes seen elsewhere, the fact remains nevertheless, that a few of the late varieties would have required a season longer by fully two weeks should the demands of the market be more discriminating in regard to the degree of ripeness. In more southern regions, such discrimination could easily be met by returning to the former practice of earlier planting. In this latitude, the task would be more difficult, since but a short time elapses between the disappearance of snow and planting time. One of the objects of the experiment under discussion, is to determine the means by which the difficulty can be surmounted in this region and the potato crop be given a longer time in which to mature. In casting about for a solution, fall planting suggested itself for several good reasons:

1st. It is safe, since the early snowfall prevents the ground from freezing, or rapidly thaws out the thin crust which sometimes forms during late fall.

2d. It saves the labor and expense of storing the seed and avoids the possible loss through rotting while wintering it over.

3d. It prevents the unseasonable sprouting of the potatoes and the consequent weakening of the seed.

4th. It relieves this much from spring work during an otherwise short planting season.

5th. It saves the cost of plowing and permits harvesting and replanting to be done simultaneously wherever a high state of fertility warrants the profitable raising of two successive crops.

In another and no less important respect the experiment is deemed of great interest. If fall planting is successful, spring harvesting should be equally so, and in such case, the farmer in this region would have a decided advantage in the way of saving storage expenses, loss from rotting through imperfect means of wintering over the surplus crop, harvesting the crop either during fall or spring as the weather may be most favorable, holding over a portion of the crop when market conditions should warrant it, and especially in preserving in the most perfect condition such portion of the crop which is intended for marketing as seed stock.

At all events, spring harvesting of potatoes would be no novel experiment. In "Michigan and its Resources," page 26, Dr. R. C. Kedzie, in mentioning northern Michigan potatoes, states: "The soil is open and porous and the tubers are protected from frost when left in the ground all winter by reason of the heavy coating of snow which falls before the ground is frozen. They may thus be wintered in the hills, and when dug in the spring have the same crisp, mealy quality so prized in potatoes first dug from the ground in the fall in other localities. These spring dug potatoes may yet become an important element of market gardening."

In Vol. 8, Pioneer Collections, page 149, Hon. Peter White, the sturdy pioneer of the Upper Peninsula, says in substance: "In the spring of 1849, on the present site of the city of Marquette, there was no sign of a human habitation save one or two Indian huts and a small log warehouse belonging to the Jackson Iron Company. In April, 1850, we started from what is now the city of Marquette, and at the Cleveland mountain, found Captain Samuel Moody and John H Mann, who had spent the previous summer and winter there." He well recollects how astonished he was the next morning when Captain Moody asked him to go with him to dig some potatoes for breakfast. This was in the month of May and the winter's snow had preserved them. He opened one or two hills and filled his pail with large and perfectly sound potatoes. He then said: "I may as well pull up a few parsnips and carrots for dinner, to save coming up again," and, sure enough, he had them in abundance. What has been stated here in regard to spring harvested carrots, parsnips and salsify, unquestionably applies to potatoes; those missed during fall harvesting and plowed up during spring having a decidedly superior crispness and flavor.

It may be safely assumed that climatic conditions in this region will change as the timber is being removed. If it should be contended, as has been frequently claimed, that insufficient moisture will be one of the first results, it is simply necessary to refer to a record of comparatively dry weather during the past season in this, a timbered region, and compare it with one of excessive rains throughout almost the entire season in older regions where timber has been completely removed many years ago.

Among the inevitable changes can only result a longer growing season together with a moderation and at least partial disappearance of unseasonable frosts, for these changes must forcibly follow an earlier disappearance of winter snows and the consequent increased heat given off by the earlier warmed up soil of the more extensively cultivated areas.

With such incoming changes, earlier spring planting will be made possible as elsewhere, though the gain thus obtained may then be possibly offset by the greater uncertainty of successful fall planting. The present experiment was merely of a preliminary character, and its continuance upon a more extended scale will be productive of more tangible results.

In planning the experiment, the aim was to ascertain whether seed potatoes cut into halves, or pieces with 2 to 3 eyes would prove as safe for fall planting as whole potatoes. It was also deemed advisable to ascertain the value of spraying against blight, as well as compare level culture with hilling up.

Whole potateos of medium size were used as seed for all varieties, two addi-

tional rows of the Sir Walter Raleigh variety being planted, one-half potato for each hill being used for row No. 2, and single pieces with 2 to 3 eyes each being used for row No. 3; the potatoes being cut the same day when planted. All seed was planted five inches deep, in hills 18 inches apart, the ground having been plowed a week before, and given two harrowings. Planting was done October 30, 1901, and permanent snow fell on unfrozen ground November 6. The rows were laid out as shown on following diagram, being 4 feet apart, 8 rods long and running north and south:

Mode of cultivation.	No. of rows.	Variety.	Size of seed used.			
Level	1	Sir Walter Raleigh	Whole potatoes	Fall planted, October 30, 1901.	Not sprayed.	Sprayed with Bordeaux mixture.
Failed to sprout	2	Sir Walter Raleigh	One-half potatoes			
Failed to sprout	3	Sir Walter Raleigh	1 piece 2-3 eyes			
Level	4	Carman No. 3	Whole potatoes			
Hilled up	5	Carman No. 3	Whole potatoes			
Hilled up	6	Pinkeye	Whole potatoes			
Hilled up	7	Rose of Erin	Whole potatoes			
Hilled up	8	Rose of Erin	Whole potatoes			
Hilled up	9	Delaware	Whole potatoes			
Level	10	Sir Walter Raleigh	1 piece 2-3 eyes	Spring planted, June 7, 1902.	Not sprayed.	Sprayed with Bordeaux mixture.
Level	11	Sir Walter Raleigh	1 piece 2-3 eyes			
Hilled up	12	Sir Walter Raleigh	1 piece 2-3 eyes			
Level	13	Hurst	1 piece 2-3 eyes			
Level	14	Hurst	1 piece 2-3 eyes			
Level	15	Pinkeye	1 piece 2-3 eyes			
Level	16	Rose of Erin	1 piece 2-3 eyes			
Level	17	Rose of Erin	1 piece 2-3 eyes			
Level	18	Delaware	1 piece 2-3 eyes			

Rows 2 and 3 were a practical failure, only 3 hills coming up in row 2, and 2 hills in row 3. The results from further experiments will determine whether this failure was due to deep planting, or to the seed not being cut several days before planting. They will also determine the exact increased yield, if any, of fall planted potatoes when the same size seed pieces are used for spring planting. In the present experiment, it is safe to assume that a portion of the increased yield is due to the fact that pieces were used for seed of all varieties planted in the spring, while whole potatoes were used for fall planting. A glance at the diagram will also show that an insufficient number of rows were planted in order to determine the exact difference between level culture and hilling up. As already stated, the experiment was more of a preliminary nature in order to determine first whether fall planting is possible. Its further value strikingly proves, however, the importance of spraying against blight, especially during a season like the past, when the disease was unusually virulent and persistent. Nine sprayings for the fall planted and six for the spring planted were necessary in order to keep the vines protected against blight. Careful observations were taken July 30 and August 18, as herewith shown, in order to note the progress of the disease upon unsprayed vines, all of which had been given an equal number of sprayings with arsenic, using water instead of Bordeaux mixture.

Time of observations.	Varieties.	Spring or Fall planted.	Per cent blighted.
July 30	Pinkeye	Fall	65
July 30	Carman No. 3	Fall	50
July 30	Delaware	Fall	25
July 30	Rose of Erin	Fall	15
July 30	Sir Walter Raleigh	Fall	10
August 18	Pinkeye	Fall	100
August 18	Carman No. 3	Fall	85
August 18	Delaware	Fall	70
August 18	Rose of Erin	Fall	80
August 18	Sir Walter Raleigh	Fall	33
August 18	Pinkeye	Spring	75
August 18	Hurst	Spring	70
August 18	Delaware	Spring	60
August 18	Rose of Erin	Spring	50
August 18	Sir Walter Raleigh	Spring	40

As heretofore related, an accident to the spray pump prevented further sprayings after the middle of August, and how rapidly blight attacked the vines previously protected will be seen from observations taken August 25, or 12 days after the last spraying had been given:

Time of observations.	Varieties.	Spring or Fall planted.	Per cent blighted.
August 25	Delaware	Fall	20
August 25	Rose of Erin	Fall	33
August 25	Pinkeye	Fall	80
August 25	Carman No. 3	Fall	33
August 25	Sir Walter Raleigh	Fall	15
August 25	Delaware	Spring	33
August 25	Rose of Erin	Spring	10
August 25	Pinkeye	Spring	50
August 25	Hurst	Spring	60
August 25	Sir Walter Raleigh	Spring	10

In the following table giving the results obtained, the time is given when the plants were sufficiently above ground to distinguish the rows. The frost of June 5 blackened the tops of the fall planted rows, though a new growth had started June 8. As will be noted, 18 to 19 days elapsed between planting time of the spring planted and the date when the rows were distinguishable. The earliest variety (Pingree) planted close by and on May 30, was up June 14:

No. of row.	Varieties.	Time of planting.	Mode of cultivation.	Sprayed or unsprayed.	Length of row.	Yield of plot in lbs., large.	Yield of plot in lbs., small.	Total yield of plot, lbs.	Yield per acre in bushels.
1	Sir Walter Raleigh..	Oct. 30....	Level.......	Sprayed........	4 rods	120	6	126	346½
1	Sir Walter Raleigh..	Oct. 30....	Level.......	Not sprayed....	4 rods	83	6½	89½	246⅛
2	Failed to sprout.....	....	....	....	....	......	......	.....	.....
3	Failed to sprout.....	....	....	....	....	......	......	.....	.....
4	Carman No. 3.......	Oct. 30....	Level.......	Sprayed........	4 rods	90	4	94	258½
4	Carman No. 3.......	Oct. 30 ...	Level.......	Not sprayed....	4 rods	42	10	52	143
5	Carman No. 3.......	Oct. 30....	Hilled up...	Sprayed........	4 rods	62	5	67	184¼
5	Carman No. 3.......	Oct. 30....	Hilled up...	Not sprayed....	4 rods	40	9	49	134¾
5	Pinkeye............	Oct. 30....	Hilled up...	Sprayed........	4 rods	58	6	64	176
6	Pinkeye............	Oct. 30....	Hilled up...	Not sprayed....	8 rods	38½	9½	48	132
7 and 8	Rose of Erin........	Oct. 30....	Hilled up...	Sprayed........	8 rods	202½	14½	217	298⅜
7 and 8	Rose of Erin........	Oct. 30 ...	Hilled up...	Not sprayed....	8 rods	176	12½	188½	259⅛
9	Delaware...........	Oct. 30....	Hilled up...	Sprayed........	4 rods	84	7	91	250¼
9	Delaware...........	Oct. 30....	Hilled up...	Not sprayed....	4 rods	44	11½	55½	152⅝
10 and 11	Sir Walter Raleigh..	June 7....	Level.......	Sprayed........	8 rods	142	10½	152½	209⅝
10 and 11	Sir Walter Raleigh..	June 7....	Level.......	Not sprayed.....	8 rods	62	11	73	100⅜
12	Sir Walter Raleigh..	June 7....	Hilled up...	Sprayed........	4 rods	58	8	66	181½
12	Sir Walter Raleigh...	June 7....	Hilled up...	Not sprayed....	4 rods	52	7	59	162¼
13 and 14	Hurst..............	June 7....	Level.......	Sprayed........	8 rods	110½	10½	121	166⅜
13 and 14	Hurst..............	June 7....	Level	Not sprayed....	8 rods	71	11½	82½	113⅜
15	Pinkeye............	June 7....	Level.......	Sprayed........	4 rods	42	6½	48½	133⅜
15	Pinkeye.	June 7....	Level.......	Not sprayed....	4 rods	29½	7	36½	100⅜
16 and 17	Rose of Erin........	June 7....	Level.......	Sprayed........	8 rods	128	9	137	188⅜
16 and 17	Rose of Erin........	June 7....	Level.......	Not sprayed....	8 rods	101	10⅓	111⅓	153⅛
18	Delaware...........	June 7....	Level.......	Sprayed........	4 rods	51½	8½	60	165
18	Delaware...........	June 7....	Level.......	Not sprayed....	4 rods	27	6	33⅓	92 1-10

Varieties.	Planted.	Sprouted.	Blossomed.	Ordinary ripe.	Thoroughly ripe.
Sir Walter Raleigh..........	October 30......	June 5.........	July 18........	September 18...	September 28
Carman No. 3.................	October 30.....	June 4..........	July 8........	September 2...	September 18
Pinkeye.....................	October 30.....	June 2..........	July 10........	August 18......	September 18
Rose of Erin.................	October 30.....	June 1..........	July 7........	September 1..	September 15
Delaware....................	October 30.....	June 1..........	July 11........	September 12...	September 22

Sprayed: June 17, 23, 28; July 5, 7, 16, 24, 28, and August 12.
Cultivated: June 18, 26; July 7, 19, 31.

TURNIPS.

In 1901, with the exception of Purple-top Strap-leaf, all varieties tested were from seed held over from last season. Two rows of each variety were hand drilled. 2 feet apart, and the plants thinned out to 12 inches in the rows. While all varieties might be planted in rows 20 or even 18 inches apart and thus produce more turnips per acre, 2 feet is none too much for the successful development of the plants, as it allows the cultivation of the crop for a longer period, which thereby not only allows the roots to make up in size what they lack in number, but keeps the ground in a better physical condition and frees it from weeds, two factors which must always remain predominant in successful farming operations.

A deficient stand was secured for the Jumbo and Purple-top Swedes, two varieties practically identical and more commonly known as Rutabagas. This no doubt was less due to the quality of the seed than to the fact that the plots were located fully 12 feet below the others, thereby causing the plants to suffer more from wet weather.

As with most root crops, planting in succession of 2 to 4 weeks is advisable in order to secure roots of medium size for table use. The larger and full grown specimens answer for stock feeding purposes, but being apt to grow woody and

afterwards become pithy when kept in storage, they are less desirable for table use. In this respect the Aberdeen is a desirable variety and deserves to be more widely known. Their size is medium large, the shape globe form and smooth, the flesh solid, fine grained, juicy, light orange colored and darker than that of the ordinary rutabagas to which they are very often preferred, though the latter will keep in good condition for a longer time.

Greystone is a very handsome variety of large, smooth and nearly globe shape; an early, white-fleshed variety, though somewhat later than the common flat turnip, and fitted for late summer and fall use.

As a rutabaga, Empress Swede is a desirable variety, somewhat smaller than Jumbo or Purple-top Swede, but more oval shaped, slightly tapering and less apt to grow prongy. The flesh is darker, light yellow, but firm, juicy and fine grained.

But for the location of the plots, Purple-top Swede and especially Jumbo, would have shown to be extremely heavy yielders. While large in size, both are excellent for table use.

The following table will serve to give something of the results of experiments in 1901, although the plots were too small to give much value to the estimated acre yields:

Variety.	Size of plot, rods.	Time of planting.	Yield of plot in bu.	Yield per acre in bu.
Jumbo Swede, first planting	¼x3	May 25	4	853.33
Jumbo Swede, second planting	¼x20	June 21	25½	816
Yellow Aberdeen	¼x6	May 25	7	746.66
Purple Top Swede	¼x18	June 21	16½	586.66
Purple top, strap leaf	¼x3	June 20	3¼	693.33
Purple top, strap leaf	¼x3	June 20	3¾	800
Yellow Aberdeen	¼x3	June 20	3½	746.6
Yellow Aberdeen	¼x3	June 21	4½	960
Greystone	¼x3	June 21	4½	960
Empress Swede	¼x9	June 21	11½	817.77

In 1902 all varieties were planted between the rows of fruit bushes, as during the previous two seasons, except that two rows of the roots were planted instead of three as heretofore, the rows being 18 inches apart, and cultivation being done with the Planet, Jr., hand cultivator.

Following are the noteworthy varieties tested for the first time:

Monarch: One of the large Swedish turnips, purple top, globe-shaped, flesh cream colored, very firm and fine grained.

Prizewinner: Resembles Monarch in shape and color, flesh slightly coarser and sweeter.

White Swede: An oval shaped rutabaga of fine cooking qualities, will not keep as long as the last two. Skin cream colored, green top, flesh white, tender, sweet.

Purple-top Milan: One of the common flat turnip varieties, of good shape and excellent cooking qualities. Flesh very firm and tender. Will keep in good condition until midwinter.

Robertson's Golden Ball: A small, finely shaped turnip of excellent merits Skin light orange. Flesh fine grained, firm, sweet and of dark cream color. A fine table variety which will keep until late fall.

Half Long Scarlet Stump Rooted: A table carrot described by its name. Flesh sweet and tender. A good keeper.

Earliest Short Horn: A small short rooted variety, well adapted for midsummer use, though will keep all winter. A very good table variety.

Guerande or Ox heart: The best known of the short rooted varieties and of excellent cooking qualities when planted close.

WINTER PRESERVATION OF CARROTS AND PARSNIPS.

The house cellar is the average farmer's receptacle for roots grown for table use. An ideal cellar is a thing more read about than seen, while outdoor pitting seldom proves satisfactory. To keep carrots and similar root crops in strictly

fresh condition for spring use, makes cold storage an almost necessity and accounts for the higher prices prevailing at that time of year. These roots are very hardy, grow underground, and very severe frosts at most injures the tops. The ground seldom freezes in this latitude or if a few inches of the upper surface occasionally freeze, they rapidly thaw out under the early snowfall. The thought suggested itself therefore that Nature's cold storage ought to prove the cheapest means for holding over a surplus crop for either market or family use. Carrots, parsnips and salsify left unharvested in 1901 and dug in May, 1902, proved to be of unexcelled quality, possessing much more crispness and better flavor than those harvested during fall or kept by any other known process. All came out perfectly sound, not a specimen showing the least sign of rot or wilt and all kept in perfect condition until the middle of June.

KOHL RABI.

To test the adaptability of this little known vegetable, a single row was planted June 3, 1901. The edible portion of the plant is the large swelling of the stem close to the ground usually 3 inches to 3½ inches in diameter, surrounded and topped with long stemmed leaves resembling those of Swedish turnips. Cooked as turnips are, it has the same flavor with the addition of a cabbage taste. It grows rapidly and will get woody if left to mature. The variety used was the early white Vienna, one of the best when the seed is true to name. Owing to the small size and number of leaves it should be pulled when 2½ inches in diameter and cooked the same day.

BRUSSELS' SPROUTS.

In 1902 the variety tested was the Imperial,—half dwarf. The plants were set out June 25th, 2 feet apart, 4 feet between rows, cultivated the same as cabbage. It is an open-head cabbage, the edible portion being the small heads or sprouts, one of which develops late in the season at the base of each leaf stalk. The value of the crop depends upon the number of solid heads sprouted. Many of the plants were damaged by Apis late in the season.

CABBAGE.

In 1901 the seed was planted in boxes April 24th; transplanted in small beds June 2nd, sprayed from the beginning to guard against cabbage worms, which were in evidence early in the season. The frost of June 8th killed many of the plants and damaged others. The remainder were set out June 21st to 24th in rows 4 feet apart, 2½ feet between plants. The varieties tested were Early Jersey Wakefield and Henderson's Early Summer, two early varieties; Surehead and Premium Flat Dutch, two medium late varieties. Very fine strong plants were also received from the Negaunee Nursery Company, the name being unknown and given as "Late Cabbage." With countless hoards of cabbage butterflies daily hovering over the cabbage fields from sunrise until long after sunset, cabbage may well be declared unprofitable, even though fancy prices are paid, and the cabbage maggot, club root and other diseases are not in evidence. The early varieties were able to ripen small, but compact heads, while the heads of the late varieties were of large size but soft. Early Jersey Wakefield ripened September 17th and Henderson's Early Summer, September 19th.

Variety.	Yield per acre. lbs.
Early Jersey Wakefield	8,576
Surehead	14,546
Premium Flat Dutch	10,500
Henderson's Early Summer	8,160
Late Cabbage	5,383

In 1902 the plants were grown for the Station by the Negaunee Nursery Company. Fine stocky plants were secured and set out June 6th, the varieties being Early York, Early Jersey Wakefield, Early Minningstadt and Late Flat Dutch, all four leading and well known varieties. They headed out August 5th, 8th and 16th, and September 12th, respectively. White butterflies producing the cabbage worm were much in evidence early in May, though none were seen after the frost of June 5th, and not until early in September, when their damage was of little consequence. The plants were set 3 feet apart in the row and the rows 4 feet apart. The following table shows the yield:

Variety.	Yield per acre. lbs.
Early York	18,694
Early Jersey Wakefield	18,948
Early Winningstadt	17,968
Late Flat Dutch	20,093

CAULIFLOWER.

In 1902 the Early Erfurt variety was tested, being planted and cultivated the same as cabbage. Of 150 plants set out June 6th, over 100 ran to seed before the middle of July. The rest developed into fine large and solid heads, ripening successively from September 2nd until the close of the season.

RADISHES.

The white Strasburg is oval shaped, large size, mild and pleasant, remaining in good condition for a long time when planted close in a row. For mild and pleasant flavor the Chartier is the best variety tested. It is long rooted, holding its shape, light-rose color and of good appearance. The Long, Scarlet White-top is sufficiently described in its name. The roots are more tapering than those of Chartier and the flavor is sharper. The White Strasburg and Improved Chartier were planted June 21st, 1901, and the White Top July 19th. The two varieties first planted were of edible size July 24th, and the Long, Bright, Scarlet, White, August 25th.

In 1902 four varieties were tested, the long Improved Chartier, three early or summer varieties, and the half-long Black Spanish, a late or winter sort. The early varieties were planted May 17th and replanted June 3rd, at which date the Black Spanish was planted. Both early and late plantings have good results for all varieties. The Long, White Vienna was edible June 26th, roots 3 inches to 4 inches long, 1¼ inches through, mild, crisp, and of good flavor.

Non plus ultra—Planted May 17, edible June 23. Turnip shaped, small, dark scarlet, crisp and very tender. An attractive variety with very small top.

Improved Chartier—Planted May 17, edible July 3. A long rooted variety of good lasting quality. Roots 5-7 inches, holding their size well and averaging 1⅓ inches at base. Pink scarlet color, flesh firm and crisp, flavor somewhat sharper than the last two.

Half Long, Black Spanish—Planted June 3, edible September 12. Flesh very firm and somewhat coarser than that of early varieties, flavor a little sharper but very good. Will develop into large size, single specimens often weighing 5-6 pounds. Should be more generally grown, since the roots will keep in the cellar until spring.

Unless radishes are grown in rich, sandy soil, they are to become tough and wormy.

LETTUCE.

In 1901 Hanson and the Cos Self-Bleaching were tested; the seed being sown May 21st for the first and June 21st for the second variety. Hanson's was edible July 15th, and remained in good condition 10 days. The heads were of good size

and quite close; the leaves are regular in outline, light green and tender. The Cos is a variety, the leaves of which are tough unless bleached. The heads are long, pointed and compact, the leaves white and tender. They will remain in good condition until late fall and are not damaged by light frosts when tied up for bleaching. The variety is similar to Romainie, grown extensively, under glass, in France.

Two varieties were tested in 1902: Early Tennis Ball and Grand Rapids planted May 17th and June 2nd. Early sowing with Early Tennis Ball and late sowing with Grand Rapids gave best results. The Early Tennis Ball, of the cabbage head sort matured July 10th, giving solid heads averaging 14 ounces. Grand Rapids, sown June 21st, was of edible size August 16th, keeping in good condition until October 15th, the heads averaging 1 pound, 14 ounces.

ONIONS.

White sets and seed, of which Yellow Globe, Red and White Globe were planted May 5th, 1901, in rows 12 inches apart. The white sets ripened fully September 13th, with diameters ranging from 2¼ inches to 2½ inches. Owing to the wet weather none of the 3 varieties from seed ripened, although both the White Globe and the Yellow Globe produced single specimens exceeding 3 inches in diameter.

In 1902 the onion maggot proved a very serious pest. The bulbs were destroyed as rapidly as they began to form and from early in the season until the close of the season. Of 2 rows, 21 rods long, 7 varieties, less than 3 quarts of merchantable bulbs were harvested.

HUBBARD SQUASH.

These were planted in two rows in hills 5 feet apart each way on June 15th, 1901, on a plot 9 rods long and with good southern exposure. The plants came up rapidly, a few being cut off by cut-worms. July 25th the plants were in blossom and as 2 to 4 squashes were well formed on each vine, the plants were trimmed and all new growth removed each week. Squash bugs were not found during the season and striped as well as spotted cucumber beetles were scarce. The vines were slightly damaged by the frost of September 19th. No damage resulted to the apparently ripe squashes, while a few frost spots on some small and unripe specimens caused them to rot later on. The squashes were picked and stored in a dry and well ventilated room on October 3rd, when in the afternoon the weather cleared up with a cold north wind, indicating a probable frost. One hundred and twenty squashes were picked from the plot, averaging 9 pounds, the largest specimens weighing 14 pounds, thus giving a yield of a little over 8½ tons per acre. While all squashes looked dead ripe, in less than two weeks all had started to rot.

In 1902, owing to the absence of the squash bug the summer squashes grew to perfection and yielded abundantly. The Hubbard or standard winter variety ripened much better, however, than during the preceding season, the ripe specimens keeping in good condition until the middle of December and the flesh being quite dry. Three hills were planted late during the preceding fall from seed of this variety previously ripened at this Station. The results from these as compared with those from plants of foreign grown seeds were practically the same as to time of blossoming and vigor of the vines, although the fruit from home grown seed kept nearly two weeks longer, when stored away in the cellar alongside of the others.

All varieties were planted June 2, Hubbard blossoming July 24.

Golden Hubbard, a late fall variety, blossomed July 30; first ripe fruit September 16. In shape somewhat similar to that of the ordinary Hubbard, though smaller in size and less warty. Color, golden yellow, with occasionally a slight splashing of green around base. Flesh very fine grained and of excellent quality.

Pike's Peak, from seed kindly furnished by F. D. Linkletter, a later variety than either of the other two, blossoming August 8; vines hardy and strong growing; of good shape and perfectly smooth; skin thin but very hard and well made to withstand light frosts. Though none were perfectly ripe at the close of the season, the flesh appeared to be very dry and of fine grain.

Mammoth Yellow Crookneck blossomed July 31 and ripened August 28; a well known summer variety of very large size and productiveness.

Bush Scallop, another well known summer variety of the scalloped type, was

tested for hardiness, the seed formerly ripened at this Station being planted late during the preceding fall. The plants reached above ground June 7, blossomed July 25 and ripened August 22. The softer texture of the flesh of summer varieties makes them less desirable for table use, while the bushy form of the plants allows closer planting.

CUCUMBERS.

Two rows, 5 rods long, were planted June 17th, 1901, in hills 6 feet apart each way with the Chicago Pickling or Westerfield variety, and on same day a plot of equal dimensions was in like manner planted with the Early White Spine. The Westerfields started to blossom July 18th, and the Early White on July 21st

Variety.	Chicago pickling or Westerfield.		Variety.	Early White Spine.	
Date of picking.	Small.	Large.	Date of picking.	Small.	Large.
July 27	28	....	July 29	5	....
July 31	84	....	July 31	13	....
August 1	4	....	August 3	14	....
August 3	57	....	August 6	24	....
August 5	104	....	August 8	66	....
August 6	29	....	August 10	80	6
August 8	258	....	August 15	413	....
August 10	110	....	August 20	140	48
August 14	388	....	August 21	253	30
August 16	192	5	August 24	351	48
August 18	226	....	August 26	300	16
August 20	268	....	August 30	85	28
August 22	175	12	September 2	338	....
August 24	359	....	September 7	120	45
August 27	201	18			
			September 12	98	40
August 30	466	....	September 13	....	46
September 15	45	28	September 24	....	48
September 7	438	....			
September 10	118	....			
September 13	....	37			
September 24	....	12			
Total	3,550	112	Total	2,300	349
Yield per acre exclusive of large size	151,466	....	Yield per acre exclusive of large size	94,800	....
Yield per acre exclusive of large size, in bushels	208.91	....	Yield per acre exclusive of large size, in bushels	130.75	....

Westerfield is a desirable pickling variety, if picked every second day or at most, every third, in case the weather is cool. Smooth specimens of good size will grow 6 to 7 inches long if left for slicing. A few were left which thoroughly ripened on the vines by the last of August. Early White is purely a slicing variety As pickles they are too slender, and apt to become soft. No attempt was made to ripen specimens of this variety and no serious damage was done to either variety by any of the September frosts. No account of what remained was kept after September 24th, but when the vines were killed October 4th, great numbers were still on the vines of the Westerfield, while the ground was literally covered among the vines of the White Spines.

In 1902 the growth of the vines was slightly retarded during June, but the season was extremely favorable for the rapid setting of the fruit. Ten hills of each variety were planted, six feet apart between the hills; the Early Russian, planted May 31, blossomed July 20, while the Early Short Green, planted June 3, blossomed July 28. Both varieties were used for pickling purposes and no fruit allowed to grow large enough for slicing.

Early Russian is very hardy, the vines short and vigorous; of good shape for

pickling when picked before the fruit exceeds 2 inches, the larger specimens having a tendency to bulge.

Early Short Green. Vines slimmer and more inclined to run, of good shape, slightly pointed, spines scattering; somewhat less productive than Russian, but better adapted as to shape for early slicing. The following table gives the actual yield, the number of pickles per bushel and the yield per acre:

Date of picking.	Early Russian.	Number of pickles per bushel.	Early Short Green.	Number of pickles per bushel.
August 8	155		19	
August 9	47		34	
August 13	134		23	
August 15	60		38	
August 19	262		77	
August 21	97		71	
August 23	75		136	
August 26	64		194	
August 27	235			
August 30	550		251	
September 1	441		195	
September 4	694		506	
September 7	550		460	
September 9	196		117	
September 11	184		79	
September 13	149		81	
September 15	104		62	
September 18	82		59	
	4,079	1,450	2,402	980

SWEET CORN.

In the year 1901 two varieties were tested, namely, Mammoth White Cory and Early Minnesota, 6 rows of each being planted June 4th on plots 3 rods long. Mammoth White Cory is one of the earliest varieties and what it lacks in sweetness it makes up in earliness and in yield. Early Minnesota is usually edible in about 75 days from date of planting. The ears are large as well as the kernels; the quality and yield are good, a few ears of the White Cory variety left on the stalks thoroughly ripened, while owing to repeated frosts those of the Early Minnesota variety remained somewhat soft. Mammoth White Cory was edible August 24th, last picking September 9th. Stalks 3 feet high, ears 6 inches to 7 inches long with 10 to 14 rows, kernels medium size, 1 to 2 ears to the stalk. Early Minnesota was edible September 13th, last picking September 20th. Stalks 6 feet high with 3 to 5 ears, 9 inches long and having 8 rows of large kernels set quite close and fairly sweet. No sweet corn was planted in 1902.

BUSH BEANS.

Challenge Dwarf and Detroit Wax were planted June 5th. The former is a black seed variety with pods light yellow, tender, stringless; blossomed July 17th, edible July 31st. The Detroit Wax has large seeds, marbled purple and white pods, tender, practically stringless, dark cream color, very prolific; blossomed July 15th, edible July 30th. Only a small per cent of the beans of either variety ripened thoroughly.

The varieties tested in 1902 were:

Jones' Stringless Wax, planted May 31st; blossomed July 21st, edible August 7th; vines were 10 inches to 12 inches high, pods 4 inches long, round, greenish, slightly curved, stringless.

Valentine Wax, planted May 31, blossomed July 16, edible August 1, height of vines 6 inches, pods 4 inches long, nearly round, yellowish green, almost stringless.

Davis' Wax, planted May 31, blossomed July 17, edible August 1, height of vines 8 inches, pods 4 to 6 inches long, flat, cream colored, stringless.

All varieties were given one spraying with Bordeaux mixture before blossoming, when about 3 inches high and all remained free from anthracnose.

Dwarf Sieva Bush Lima, planted May 31. No pods formed.

Early Golden Cluster Wax, a pole bean planted May 31. Pods did not begin developing until early in September and but few arrived at an edible stage, when damaged by frost.

TOMATOES.

The plants for the season of 1901 were started in boxes from seed planted April 24th. The planting was too late to make the raising of tomatoes successful when taking the shortness of the season into consideration. The plants were well loaded and were not damaged by the frost of September 9th and but slightly so by the frost of September 19th. None ripened.

In 1902 tomatoes were tested again; the varieties, the Atlantic Prize and Noltie's Earliest. The plants were grown in the greenhouse by Mr. Fred Greenwood of Manistique. The plants were set out June 11th; blossomed fully but none of the fruit ripened owing, undoubtedly, to the unfavorable weather of June, yet it seems safe to assume that both of the varieties tested will ripen with normal weather during the first period after being set out.

GARDEN PEAS.

Three varieties of garden peas were tested in 1901, namely, Bliss' American Wonder, a short vine variety, Earliest of All or "Alaska" and McLean's Advancer, two tall varieties. All varieties blossomed June 27th or 28th. The Alaska being first as to earliest for picking, the Advancer being first as to productiveness and Bliss' American Wonder best for quality.

For the season 1902 the varieties tested were: May Queen, First and Best, Alaska, American Wonder, McLean's Advancer, Bliss' Everbearing and Melting Sugar. The first variety named was planted May 19th, edible July 20. Length of vines, 22 inches, foliage pale green, 3 pods per vine. Pods 2 inches long containing 4 or 5 peas of medium size and fairly sweet. The second variety was planted May 19th and was edible July 22d. Length of vines 24 inches had 4 to 5 pods, foliage dark green. Pods 2 inches long, containing 5 peas, small and sweet. Alaska planted May 19th. Edible July 21st. Vines 30 inches averaging 6 pods, foliage light green. Pods 2½ inches long containing 6 to 8 peas, small to medium size, not sweet.

American Wonder, planted June 2, edible August 6. Vines 18 inches with 12 to 16 pods, foliage dark green, pods 2½ inches long containing 4 to 5 peas, large, sweet.

McLean's Advancer, planted June 2, edible August 8. Length of vines 28 inches having 18 to 22 pods, foliage light green. Length of pods 2¾ inches containing 5 to 6 peas, medium size, sweet. This and American Wonder are very prolific varieties of best quality.

Bliss' Everbearing, planted May 19, edible July 30. Length of vines 4 feet, averaging 10 to 14 pods, foliage dark green. Pods 2¾ inches long, containing 3 to 5 very large and sweet peas.

Melting Sugar. Edible pod variety. Planted May 19. Length of vines 5 feet, averaging 8 pods, foliage light green. Pods 3½ inches long, flat, usually curved containing 6 large peas. Quality excellent and a good yielder.

SPINACH.

This is a vegetable that should be grown more frequently than it is. In 1901 2 rows 16 inches apart and 3 rods long were planted May 7th and subsequently replanted July 19th; the variety used being Round Summer Broadleaf. Seed should be sown early, as the plants will not get damaged by light frosts. In many localities the seed is sown late in the fall.

In 1902 two varieties were planted on May 17th, namely, the Victoria and Long Standing Prickly. Both varieties ran to seed before the leaves developed to an edible size. Subsequent planting on June 21st gave favorable results; the Long

Standing Prickly being of edible size July 20th, the light green colored leaves being tender and of good size, Victoria was of edible size July 21st, leaves dark green, tender and very large.

GARDEN BEETS.

In 1901, 3 varieties were tested, namely: Early Eclipse, Bassano and Half Long Blood Red, the plots being 3 rods long with 2 rows 2 feet apart and the plants thinned out to 8 inches. The Early Eclipse has a dark red flesh faintly mixed with white, and is a rapid growing variety, averaging 3 to 3½ inches in diameter if left to grow until fully matured, but more tender when pulled earlier. The Bassano is a short tapering variety of large size, the skins purple and the center of alternating red and white layers, 4 inches in diameter and nearly 5 inches long when fully matured. Half Long Blood Red is the darkest colored of the three, and without any trace of white color. They are long, tapering, holding their size quite well, usually 2½ inches to 3 inches in diameter and 6 inches to 7 inches long.

The following table gives yields, calculated from the very small plots mentioned:

Variety.	Seedsman.	Date of planting.	Yield per acre.
Early Eclipse (first planting)	D. M. Ferry & Co	May 6	320
Early Eclipse (second planting)	D. M. Ferry & Co	May 22	213.33
Early Eclipse	Vaughan Seed Co	May 27	266.66
Bassano	Vaughan Seed Co	May 22	266.66
Half-Long Blood Red (first planting)	D. M. Ferry & Co	May 6	320
Half-Long Blood Red (second planting)	D. M. Ferry & Co	May 22	533.33

For the season of 1902, 4 varieties were tested: Crosby's Egyptian and Detroit Dark Red Turnip, two early varieties planted May 17, and Half Long Blood and Improved Long Dark Blood, two late sorts planted June 3.

Crosby's Egyptian matured July 26. A good variety for earliness and good shape. Flesh dark, but coarse.

Detroit Dark Red Turnip matured August 5. Fine grained and of good form and quality as an early sort.

Both of the late sorts are standard among the long rooted varieties and of excellent quality.

CARROTS.

The carrots were planted in rows 16 inches apart and the plants thinned out to 4 inches in the row. The roots developed to good even size, clean and free from prongs, for the season of 1901.

Chautenay is an excellent table carrot of medium size and dark orange color, slightly tapering and abruptly terminating with a short, fine tap-root. The flesh is orange colored, brittle, juicy and mild flavored. What it lacks in size it makes up in quality and good shape.

Scarlet Intermediate is from seed kept over from last season. Somewhat larger than Chautenay, but of good size for table use. In shape more tapering and with a longer tap-root. Dark orange colored, flavor and quality good. Flesh quite brittle and orange colored with a white center.

To these two are purposely added two varieties principally grown for stock feed; similar varieties being grown for table use in many parts of Europe, and more especially those of the White Belgian variety. Both varieties are of slender shape 1½ to 2 inches in diameter, holding their size well, although averaging 12 inches in length, 3 to 4 inches of which grows above ground and which as a consequence is colored light green on the outside.

White Belgian is the sweeter of the two, and while the flesh is somewhat coarse, the flavor of it, when well stewed and mashed, is sweeter and not unlike that of the parsnip.

Victoria, the other variety, is of the same texture, fairly sweet and with a more pronounced carrot flavor, the flesh instead of white, being light orange colored.

The following table will give the results:

Variety.	Time of planting.	Yield per acre.
Chautenay (first planting)	May 4	460 bushels.
Chautenay (second planting)	May 23	400 bushels.
Scarlet Intermediate	May 4	586.66 bushels.
Victoria	May 25	533.33 bushels.
White Belgian	May 25	426.66 bushels.

CELERIAC.

In June, 1902, the plants were set out. Edible September 20. This vegetable deserves to be more widely known, being extremely hardy and of easy cultivation. It is mostly used for flavoring soups, except by the Germans, who use it in the same manner as potatoes for potato salad. Planted 7 or 8 inches apart and 3 feet between the rows it will yield abundantly, and succeed best where celery will. The edible portion develops into a bulbous root weighing 4 to 6 ounces when trimmed, and these bulbs when properly packed away in the cellar will keep almost until spring. Where, as throughout this region, the ground but slightly freezes, the plants may be safely left unharvested for spring use.

CELERY.

In 1901 four rows of the White Plume and two of the Golden Self-branching Celery were set out July 13th. The late date at which the plants were received and the extreme hot weather of the week following practically ruined the crop. The extreme heat may be judged from the fact that the standard thermometer in Marquette thirty-five miles distant registered 108°, the highest in the state.

The ground was extremely wet when the plants were set out, this moist condition of the soil combined with the intense heat exhausted the vitality of the plants. What they gained during the cooler and wet weather of the latter part of the month they lost during the next hot and dry week of the beginning of August. September was favorable and had the plants been far enough advanced they would have been able to stand the continuous and cool rains; as it was they remained almost stationary at a height of 4 to 7 inches until the close of the season and no attempt was made to bleach.

In 1902 three varieties were tested: Golden Self-blanching, White Plume and American Golden. The plants were grown by Mr. Fred Greenwood who furnished the tomato plants. They were set out June 11th and 12th and grew rapidly, though somewhat checked during the dry weather of July and August.

White Plume, an early variety, remained somewhat undeveloped, though most plants by the middle of September were of large size, well blanched and of very good quality.

Golden Self-blanching is a medium late variety of small size, excellent quality and growing close and solid.

American Golden is a late variety of large size, handsome appearance and fair quality.

Blanching was done by means of bringing the dirt against the plants as the season advanced, and owing to favorable weather conditions no rust developed.

Late in October, most of the undeveloped plants were packed in 4 inches of soil and transferred to a darkened place in the cellar where by the middle of December they had made 12 to 16 inches of new growth and developed stalks of small size but much better quality than any grown out doors.

To test their keeping quality, some plants of the late varieties were left unharvested, a layer of 4 inches of straw being spread over the tops early in November.

PUMPKINS.

The season of 1902 was favorable for pumpkins, except that June weather was equal to a shortening of the growing season by from 2 to 3 weeks, and that one-third to one-half of the fruit was partially ripened in consequence. Pumpkins

were planted 8 feet apart each way and cultivated once each week as long as the length of the vines permitted. The varieties tested were as follows:

Pie Pumpkin. Planted June 2, blossomed July 26, first ripe September 8, small, averaging 7 to 8 pounds, round, smooth, lemon colored, very fine grained and the sweetest fleshed of any variety.

Pie Pumpkin. Seed from the same variety heretofore grown at this Station was planted in order to note any possible difference in behavior of plants grown from seed ripened in northern latitudes. Planting was done on same day, i. e., June 2. The early growth was much more rapid, the vines more vigorous and the color of the leaves darker. Blossomed July 24. First ripe September 4. In size there was no appreciable difference between the two although one-third more fruit ripened from home grown seed.

Pumpkin called "Detroit" for convenience sake, from seed kindly furnished by J. E. Morse, Detroit (Mich.). Planted June 2, blossomed July 31, first ripe September 18, and two more specimens ripened after the frost of September 19 Medium large, averaging 16 to 20 pounds, round, slightly ribbed, bright orange colored, flesh medium fine grained, not sweet. A hardy growing variety of good merits.

Mammoth Chili. Planted June 2, blossomed July 31, fruit ripe September 19. The largest and most vigorous growing variety, the ripe specimen taken for exhibition at the State Fair exceeding 50 pounds. Flesh coarse grained and well adapted for stock feeding purposes.

Mammoth Tours. Planted June 2, blossomed August 5. Fruit long, almost cylindrical shaped, though slightly bulged towards blossom end. Color white, splashed and heavily striped with light to dark green. The nearest ripe specimen was 20 inches long, 11 inches in diameter and weighed 42 pounds.

MANGELS AND STOCK BEETS.

In 1901 to the list of varieties were added two of sugar beets which were grown as stock beets and not determined for their sugar content, owing to the fact that the seed had been held over from the preceding season. These and the mangels were hand drilled in rows 2 feet apart, the plants thinned out to 12 inches, while the three varieties of white beets at the head of the list were planted in rows 16 inches apart and the plants thinned out to 5 inches, thus allowing the same width for all plots whether planted in 2 or 3 rows, namely, one-fourth rod, and as all plots were 3 rods long, the surface is not repeated in the table.

As with all root crops, frequent cultivation was given with a hand cultivator as long as the size of the tops made it possible.

Owing to their smaller size and deep rooting habit the white stock beets should receive considerable attention from stock feeders. They are sweet, solid fleshed and will stand more wet and cold weather than any mangel. Neither mangel or stock beet can be successfully grown unless the soil is deep, well cultivated and containing a large amount of vegetable matter enabling it to store up a large amount of moisture. The season was too wet for the successful raising of mangels, and the plots giving the highest yields were those on higher and consequently better drained ground.

	Variety.	Time of planting.	Yield of plots in bushels
Stock beet	Improved short white	May 4	5¼
Stock beet	Mammoth White intermediate	May 4	5
Stock beet	Giant white vosges	May 4	5
Mangel	Mammoth yellow intermediate	May 23	4¾
Mangel	Eiffeltower	May 27	4½
Mangel	Perfection mammoth long red	May 22	3¼
Mangel	Giant yellow globe	May 9	2¾
Mangel	Golden tankard	May 7	1½
Mangel	Obendorfer yellow	May 27	2½
Mangel	Lentowitzer	May 27	3¼
Mangel	Mammoth long red or saw log	May 23	4
Mangel	Eckendorfer red	May 27	4
Sugar beet	White silesian green top	May 9	3
Sugar beet	Danish improved	May 7	2¾

PARSNIPS AND SALSIFY.

Three varieties of parsnips and one of salsify were planted May 6th, 1901, in rows 2 feet apart, 2 rows to each plot and the plots 3 rods long. The tops of all varieties made a satisfactory growth during the season, but the roots made no appreciable growth until the last of August. The development not being satisfactory by October 5, and considering that the plants are able to withstand even extreme cool weather, it was thought best to leave the plots unharvested until spring and thus enable the roots to make some additional growth during the balance of the fall season. None of the severe October frosts had apparently damaged the tops which were still of a healthy green when finally buried under the November snows.

A plot of same dimensions, planted May 22, with Chautenay carrots was also left unharvested, in order to test the effect upon the roots when left out unprotected during winter.

HERBS, ORNAMENTALS AND MISCELLANEOUS GARDEN VARIETIES.

Variety should be the aim of the home garden. Many things not commonly seen may be profitably grown near the house, for if the returns cannot be expressed by the dollar sign, the dividends are none the less assured by the increased health of the family and the moral influence of beautified home surroundings. With this end in view the following varieties were tested in 1902:

Dandelion. An improved variety of the common weed which it resembles in shape only, being considerably larger and remaining much longer in good condition for "greens" or salad. The sight of housewives and children hunting for the weed early in spring among old pastures and along highways, suggests the planting of this variety if only as a matter of time saving.

Corn Salad or Lamb's Lettuce (Valerianella Olitoria, Poll.), a weed cultivated in Europe and sparingly naturalized. Sweet and tender early in spring and a pleasant substitute for lettuce. Very hardy.

Sorrel, Long-leaved French (Rumex acetosa, Linn.), a cultivated variety of the common weed. The leaves are large, tender and juicy, very broad and often 10 inches long, retaining the pleasant acid flavor of the original weed. Much prized in France where it is cultivated as a spring vegetable and used singly or mixed with spinach.

Cress, Gray Seeded Early Winter. A good substitute for the true water cress and adapted for high ground. Leaves larger and coarser.

Water Cress will re-seed itself and spread indefinitely when once planted alongside of a running spring or brook.

Mustard, White English. Cut when 6 to 8 inches high the young plants make a good substitute for spinach, while successive seedings will insure a supply during the entire season when desired. As hardy as the common weed and will grow nearly 6 feet tall when broadcasted or drilled close. The seed being high priced, it ought to prove a profitable crop for field culture. The plant itself when cut while beginning to blossom ought to be of good feeding value, although this could not be definitely ascertained owing to the absence of any live stock on the Station. Three plots were planted as follows:

Plot 1. Planted May 17, 3x25 feet, cut for "greens," three cuttings being secured at an interval of ten days between each cutting, the plants growing new branches when cut 3-4 inches above ground.

Plot 2. Planted June 4, 12x25 feet. One-half of the plot was cut for greens once, then allowed to run to seed together with the other half of the plot. The yield gave 27 pounds of straw and 7 pounds of well ripened seed, or at the rate of 1,016½ pounds of seed per acre.

Plot 3. Planted July 25, 6x25 feet. Plants were cut when nearly in full blossom and averaging 5 feet 4 inches high. The yield of green fodder was 113 pounds or 32,815 pounds per acre. Considering the enormous amount of vegetable matter to be plowed under, this crop ought to suggest itself as a cover crop for orchards.

Chervil, the pleasant flavored foliage is used in the same manner as parsley, the leaves being broader and less curled.

Parsley, a well known herb, extremely hardy, and should be more generally found in the home garden.

Ground Cherry (Physalis Pubescens, Linn.), common husk or strawberry tomato. The well-known yellow or greenish fruit is much valued either in the raw state, or for pies or preserves. The seed is very slow in germinating and only a few plants ripened fruit.

Pepper, Large Squash. Some green peppers were secured but none ripened.

Okra, produces the well-known mucilaginous pods which are cooked green or used to thicken soups. None of the plants fully developed.

Peanuts, Spanish. The plants made a slow growth and blossomed August 15, but none of the nuts had attained full size when the September frost killed the plants.

Fennel. Cultivated for the sweet aromatic foliage and fruit.

Dill. Grown as fennel, which it greatly resembles, both being well-known herbs used for flavoring pickles, and both being of unsurpassed hardiness.

Anise. Used the same as fennel and dill. The foliage and fruit are much more sweet scented, and the ripe seed is much used in Europe for flavoring pastry. Almost as hardy as the former two.

Poppy, White (Papaver Somniferum, Linn.), Opium Poppy. The seed is much used in Europe and as anise or caraway seed, owing to its rich, nut-like flavor. The plants averaged 4 feet high and began to blossom August 10, the simplicity of the single, pure white flowers being as striking as their enormous size which averaged 6-8 inches in diameter.

Martynia, Unicorn Plant. The curious, long beaked fruit is used for pickles. The plants are quite hardy and ornamental, the fruit being no less conspicuous for its odd shape than the large wax-like flowers of whitish color with purple and yellow spots.

Nasturtium. The hardiness and unsurpassed beauty of this plant should make it a favorite near every home. The seed pods just before beginning to ripen make a delicious flavoring for pickles. The tall or climbing variety was tested, a framework of lath 4 feet high being given for support. The frame was well covered early in August with the multi-colored wall of bright hued, velvety flowers.

Sunflowers. A black striped Russian variety was tested; the seeds planted May 30. The plants grew rapidly, being cultivated by hand until they were about 2 feet high. They reached an average height of 10 feet and some specimens exceeded 12 feet. The seed heads were well filled, large, individual specimens being 23 inches in diameter, and all ripened the seed thoroughly, having started to blossom August 11. The stalks were heavy and of good, even thickness, individual plants exceeding 8 inches in circumference at the base.

MUSK- AND WATER-MELONS.

Several varieties were planted May 31 and June 2, 1902. The growth of the vines was seriously checked during June and none completely recovered afterwards except Early Citron Muskmelon which blossomed July 26 and ripened its fruit September 15, the flesh being coarse and not sweet. Citron Melon blossomed July 24 and ripened September 12, a well-known hardy variety used for canning and preserving purposes. Rockford from seed kindly furnished by N. A. Stoddard of Reed City (Mich.) was planted June 6 and blossomed July 30; probably the best of the green fleshed muskmelons. The vines were conspicuous for their hardiness and vigorous growth, but while blossoming until late in the season, no sign of any fruit could be found.

ORCHARD, VINEYARD AND SMALL FRUITS.

In 1901 as soon as the snow had sufficiently disappeared the fruit trees were removed from the south side plots, where they had grown in nursery rows. From the fact that a considerable number of large, loose stones are everywhere encountered close to the surface, the work of transplanting progressed slowly, none but good soil being used around the roots. The trees were planted one rod apart each way and eight feet each way was given to the grape vines. All varieties had

stood the winter well, the snow on the south side plots having been deeper than the average, owing to the northern exposure. Several hundred, however, were damaged by the alternate freezing and thawing when the snow had nearly disappeared. The damage consisted in the bark splitting just above ground to a height of 2 to 4 inches. The splitting did not occur from any single direction and the bark was found split in this manner on the north, east and west sides, as well as on the south side. The plum trees were damaged less than the apples or pears, and the cherry trees escaped altogether. Of the apple trees, a few Russian varieties also remained unhurt, notably Zolotareff, Charlamoff and Borovinka. The trees were planted somewhat deeper than formerly, and they soon recuperated and none died from this damage.

The tips of all grape vines had been winter-killed, and were killed back by three severe frosts again on May 14, May 25, and June 8, but all made a fair growth during the season.

Pear trees which had made the best growth during the preceding season did worse during the present one, and were in a very bad condition at the close of the season, many of them having been attacked by blight.

The cherries have done much better than any other fruit trees, and the varieties have kept an even pace.

All trees were frequently sprayed until late in the season, both for blight and insects, while thorough cultivation was kept up until the middle of July.

Owing to the nature of the soil and the location of the plots the season has been unfavorable to fruit and other crops with the exception of roots. Aside from a wet season, they had to suffer from the surplus water finding its way from the terraces to the creek. An open ditch was dug around the plots at the beginning of the season. While it materially helped to divert a considerable portion of the drainage, it did not prove sufficiently effective during a season as wet as the one just past has been.

STRAWBERRIES AND BUSH FRUITS.

Owing to the comparatively mild weather of the preceding winter, and more especially to the great depth of snow, the small fruits came out in a fair condition when the snow disappeared in the spring of 1901. One-half of the strawberry plants had been mulched with clean straw during the latter part of November when about 8 inches of snow was on the ground, and both mulched and unmulched plants were in a thrifty condition at the beginning of the season.

The main damage to the bush fruits was the torn condition of the vines caused by the ever settling mass of snow in which they had been buried. The stoutness and less branching habit of the Loudon enables this variety to ward off this damage somewhat more successfully. Although winter-killing of the tips was the rule, the damage was of slight consequence except to the blackberries and more so to the Eldorado variety, which remained weak and was in no shape to form new plants later on. All other varieties made a satisfactory growth after being pruned and the black-caps were in good condition for layering later in the season.

The currant and gooseberry varieties were pruned and cut back, although the tips of none had been winter-killed, and the thrifty bushes of all varieties were layered for new plants later on.

The May frosts did not seem to damage the early blossoming varieties to any considerable extent, but all varieties were either in fruit, blossom or advanced budding stage when struck by the frost of June 8, the failure was practically complete. Nearly full grown currants and half grown gooseberries dropped off and most strawberry blossoms subsequently opened with blackened centers. Raspberries apparently escaped; the stouter canes being well loaded later on. Whether still feeling the effects of the frost, or simply on account of the burning heat of the middle of July, the berries softened before ripening and most of them dropped off.

The varieties mentioned more specifically below are those which have shown the greatest resisting power to the various unfavorable conditions. Insects were not troublesome and no disease was manifest during the season except mildew which was not appreciably checked on gooseberry bushes after repeated applications of a

solution of liver of sulphur, though largely subdued after making its appearance upon currants. Frequent and shallow cultivation was given whenever the condition of the ground made it possible, and at the close of the season strong cedar posts were set up about 40 feet apart, two No. 8 galvanized wires passed through them, one 2½ feet and the other 4½ feet above ground. To the lower wire the canes of the Columbian Raspberry were tied with narrow bandages of cotton when about 10 inches of snow were on the ground, and thus the tearing of the heavily branched canes from the weight of snow will be avoided during the coming winter. The strawberry beds were extensively enlarged at the beginning of the season, both with new varieties and with plants taken from the old bed. Considering the muddy condition of the beds during nearly the entire season, the new plants made a remarkable growth, setting a profusion of new plants and remaining practically free from disease. The whole plantation was mulched with clean straw after the ground was covered with 8 to 10 inches of snow. Among the strawberries, Excelsior has shown remarkable vitality, producing quite a few berries even though first in blossom. The flowers are perfect. They started to blossom May 26. The plants are medium size but strong and bushy. The berries are medium to large size with a pleasant acid flavor, bright scarlet, the color extending through the whole berry; conical shaped and quite firm in texture. The first fruit was ripe June 22 and the last was picked July 13.

Sample was next in hardiness. The plants are tall, showy and very strong. The blossom is imperfect; plants begin to blossom June 1st. The berries are larger than Excelsior and broad conical shaped, mild, subacid and dark scarlet colored, the color extending through the berry, and the texture firm. Ripened July 1 and lasted until July 22.

Among the raspberries the Columbian showed the strongest vitality and developed very stout and strong branched canes by the middle of the season. The berries are purple in color and covered with a gray bloom, which is objectionable only to those unacquainted with the quality. In form they resemble the ordinary black cap varieties, though somewhat less flattened. Of medium texture, excellent quality and very juicy. Blossoming June 21, the berries were ripe July 26 and lasted until August 22.

The warm weather during April and May of 1902 induced an early growth which while not killed by the intervening frosts, made but little headway until late June. Currants began blossoming May 17. Strawberries May 18 and cherry trees May 20. Subsequent late frosts as shown in Table of Temperatures were:

May 26—32 degrees; May 27—29 degrees; May 28—26 degrees; and June 5—26 degrees. As will be shown here, these temperatures were much lower in the neighborhood of the small fruit plots, and as 20 degrees is commonly termed "killing frost," the question may still be asked: What is killing frost as viewed from the reading of instruments, when it is considered that no fruit bush, plant or tree was damaged, and that the damage from the last or June frost was confined to the killing of a few fruit blossoms and to the blackening of a few early sprouted potato vines. Between first blossoms and first ripe fruit of strawberries there may intervene 15 to 28 days when the weather is favorable. With late frosts and prolonged cold weather, the time may extend to as much as 37 days (see Bulletin 130, Michigan Experiment Station). Since 39 days intervened between the first blossoming and the first ripe fruit of the earliest strawberries (Excelsior) and since the two additional days may well be ascribed to the more northern latitude, with its consequent cooler weather, it becomes evident that fruit ripened in spite of the heavy May and June frosts.

That the frost of May 28 was heavier than pointed out at the beginning of this Bulletin, and shown in the Table of Temperatures, and that this was particularly the case in the neighborhood of the small fruit plots as above stated may be evidenced from the following observations:

As all signs during the afternoon of May 27 pointed towards a heavy frost as likely to occur during the following night, an effort was made to give some slight protection to the young cherry and plum trees which were then in blossom. With this end in view, logs and stumps were piled up 6 to 8 feet high and 6 rods north of the orchard, the piles being each 20 to 30 feet long, 4 to 6 rods apart and extending east and west. The instrument shelter for recording temperatures is on a line even with the most southern row of cherry trees, or 22 rods south of the line of log piles. Forty rods west of the nearest log pile, a self-registering minimum thermometer was fastened to a fence post practically on a level with the

instrument shelter. A similar thermometer was fastened upon the outside of a small tool house which stands about 80 rods south of the shelter, approximately 30 feet lower than the shelter, and about 15 feet higher than the strawberry plots.

The maximum temperature, 45 degrees, was reached between 1 and 2 o'clock p. m. At 5 o'clock p. m. the sheltered thermometer registered 39 degrees, at 6 o'clock 34 degrees, at 7 o'clock, when the log piles were set afire 32 degrees and at 8 o'clock 30 degrees, when the thermometer on the fence post registered 29 degrees, the two preceding readings of this thermometer being the same as those of the shelter thermometer, i. e., 34 degrees at 6 o'clock and 32 degrees at 7 o'clock. No further observations were taken during the evening, the smoke and heat being driven due south by the cold currents, and the fires which were attended to until after 11 o'clock p. m. were still burning early next morning, when the reading of the three thermometers showed:

In shelter, 26 degrees; on fence post, 24 degrees; on tool house, 23 degrees.

The thermometers were the official instruments as used by the U. S. weather bureau, and were kindly furnished by Director C. F. Schneider of Lansing. As a further evidence that the fires afforded a slight protection to the extent of 2 degrees, a later observation was taken on September 11, when no fires were built, the readings next morning showing:

In shelter, 30 degrees; on fence post, 30 degrees; on tool house, 27 degrees.

On September 12 the thermometer was removed from the fence post and placed upon a post of even height in the strawberry plots. Observations the next morning and the morning of September 19, read: September 13, in shelter, 31 degrees; on tool house, 29 degrees; on strawberry plots, 29 degrees. September 19, in shelter, 25 degrees; on tool house, 23 degrees; on strawberry plots, 23 degrees.

It is evident therefore that the actual temperature surrounding the plots of strawberries and fruit bushes which are all located 2 to 15 feet below the tool house, were as follows:

May 26—30 degrees; May 27—27 degrees; May 28—22 degrees, and June 5—24 degrees.

The fair crop which ripened under such adverse conditions would give rise to the following questions:

1. Will certain fruit blossoms at certain stages stand a severe amount of frost, and even more than what is commonly termed as killing frost, i. e., 26 degrees?
2. Was immunity from the severe frosts the result of heat previously stored up in the soil and lingering close to the surface during the few frosty hours of the nights?
3. Were the plants which were unable to withstand even less severe frosts during the preceding seasons, now acclimated, and able to stand severer frosts than they could further south where they had been propagated?

Had additional observations been taken, the first two questions might have been answered even at that time.

In 1902, as during the preceding season, the beds were mulched with clean straw when about 10 inches of snow was on the ground, this mulch being subsequently left between the rows. A small portion of the beds had been left unmulched during the last and preceding winter, and careful observations showed that the clear snow is a much better mulch, at least upon the station plots.

As heretofore shown, the plots received the drainage from the higher adjoining terraces. The time when the mulch has to be removed early in spring is one when work upon the plots is practically impossible, the soil being a deep loam filled with spongy vegetable matter, and "muddy" being the mildest term which can be used to describe the condition of the plots until late spring. The drier weather of this season enabled the earlier removing of the straw, and to this is at least partially due the better frost resisting power of the plants.

Until the ground is tile drained, experiments with strawberries on the present plots are valuable only in as far as they will show what strawberry plants will do in this region when subject to the worst possible conditions. Meanwhile, however, a small plot was laid out on higher and well drained ground, and a dozen of the leading varieties were planted May 9 for fruiting next season, the main object being to note the behavior of a few varieties such as Marshall and Michigan when planted on a sandy loam. The matted rows were thinned out and narrowed down to 12 inches after the close of the fruiting season, and no winter mulch was applied, it being the intention of hereafter applying the mulch between the rows only during the fruiting season. Among the varieties not heretofore described may be noted:

Clyde. Medium size, bright scarlet, round conical shaped. Of good flavor, but not of the best shipping qualities.

Glen Mary. Very large size, of broad conical shape, bright crimson color; an excellent market variety and of good quality.

Bryant. A large berry and a heavy yielder. Dark crimson color. Not the best for flavor, but firm and a good shipper. Its shape is uncertain and even the same plant is liable to have berries of three to four different shapes.

Brandywine. Bright crimson, of broad conical shape, somewhat longer than Glen Mary. One of the best late varieties and of superior flavor and quality.

Marshall. Dark crimson, large size, broad conical shaped. The berries are firm and of excellent quality.

Michigan. Dark red and irregular in shape, though much better than Bryant in this respect. The latest ripening variety. Very firm and of good flavor and quality. Needs mulching, fruit stems being rather short. Produced the largest berries of any of the varieties tested. The behavior of the plants of this variety and of Marshall suggested a drier soil as more beneficial and as far as plant growth is concerned, the improvement on the new plot was soon conspicuous.

Parker Earle. Dark red, round, conical necked and running to a point. Medium size, of good flavor and fair shipping qualities as a medium late variety.

Success. Broad conical and large size, dark red, of good quality and fair flavor. Not very firm, and better for home use than market.

Haverland. Light scarlet, medium size and long conical shaped. One of the best for fine flavor and quality, but not very firm as a shipping variety.

Bederwood. Medium size and berries round and of even size. Light red and of fair shipping qualities. The heaviest yielder of all varieties, the plants being extremely hardy and vigorous. Its flavor is perhaps best described when classing it as the "Ben Davis" of the strawberries.

Gandy. Very large size, broad conical and light crimson colored. Nearly as late as Michigan. Of unsurpassed shipping qualities and excellent flavor. Plants very large and vigorous, resembling those of Sample, and like this variety, has stout, erect fruit stems carrying the berries well above ground.

Mayflower. Small to medium size. Light scarlet colored. Round, conical and somewhat pointed. Of fair shipping qualities as one of the earliest varieties. Flavor fair.

Bubach. Large size, and crimson colored. Depressed conical shaped. Of good flavor and shipping qualities. A good and profitable variety, having hardy and vigorous plants.

TABLE OF STRAWBERRIES—(In matted rows 4 ft. apart)—1902.

Varieties.	Sex.	Length of of row in feet.	First blossom.	First ripe fruit.	Last ripe fruit.	Yield in quarts.	Yield per acre in quarts.
Sample	Imperfect	1,140	May 31	July 7	July 31	276½	2,641⅓
Success	Perfect	380	May 24	July 5	July 31	36½	1 046
Brandywine	Perfect	200	May 31	July 9	July 31	23½	1,279 3-5
Mayflower	Perfect	135	May 20	June 28	July 15	6	484
Bederwood	Perfect	460	May 20	June 30	July 31	183½	4,344 1-7
Haverland	Imperfect	460	May 29	June 29	July 31	103½	2,450¼
Michigan	Perfect	760	June 2	July 12	July 31	15½	222 1-10
Excelsior	Perfect	1,520	May 18	June 27	July 26	156	1,117 3-5
Glen Mary	Imperfect	30	May 31	July 9	July 28	1½	544½
Gandy	Perfect	135	June 1	July 11	July 31	23	1,855⅓
Clyde	Perfect	570	May 24	July 3	July 26	68	1,299⅛
Marshall	Perfect	95	May 30	July 7	July 31	1	114 3-5
Bubach	Imperfect	100	May 30	July 7	July 24	10	1,089
Parker Earle	Perfect	580	May 31	July 9	July 31	59	1,107¾
Seaford	Imperfect	180	May 31	July 8	July 21	9	544½
Bryant	Perfect	180	May 31	July 6	July 31	19	1,149½

GOOSEBERRIES.

In 1902 mildew was fully as prevalent as during the past season. Five sprayings with liver of sulphur had little effect towards checking the progress of the disease, though the American varieties were less affected and ripened a fair crop of fruit. Some of the English varieties were too weak to even blossom, and the few which blossomed, failed to set any fruit.

In marked contrast with these, were a half dozen plants of the Houghton variety, kindly furnished by Fred Greenwood of Manistique (Mich.), not one showing the least sign of mildew during the entire season of 1902.

Downing is the most vigorous and best yielding variety. The berries are of good size, round oval shaped, quite sweet and whitish green in color. Blossomed May 20. Ripe July 25.

Red Jacket blossomed May 21 and ripened fruit July 28. Berries very large, round, oval oblong and greenish red in color. Very sweet and of good flavor.

Pearl blossomed May 21, berries ripened July 30. Berries somewhat smaller but sweeter than Downing; round oval shaped and green.

CURRANTS.

Of the three varieties tested Victoria was the most productive. Prince Albert being slightly better than North Star. Mildew slightly affected the bushes nearest to the gooseberries, but disappeared after one spraying.

Victoria. Blossomed May 19, 1902. The fruit ripening July 21. Berries red, round and of good size and flavor.

Prince Albert blossomed May 18, ripening July 18. Berries very large, dark red, round and of excellent flavor.

North Star blossomed May 17, the fruit ripening July 20. Berries red, round, more acid and smaller than the other two.

BLACKBERRIES.

The bushes passed unharmed through the winter and made a rank growth throughout the season of 1902.

Erie blossomed June 19 and on August 5 was still in blossom, though for some unaccountable reason no fruit set during the entire season.

Eldorado which had made a poor showing during the preceding season, made even a more vigorous growth than Erie. Only one bush blossomed and produced a large bunch of fine berries of very large size and very sweet. Blossomed June 24. Ripe fruit August 20.

RASPBERRIES.

Three varieties are on trial: Loudon, a red variety; Columbian, a purple cap, and Older, a black cap.

All varieties, especially the Columbian, made a splendid showing until shortly after the fruit began to ripen, when hot, dry weather caused premature ripening, and the fruit either dropped off or remained undersized.

Loudon is a hardy variety, the fruit being large, firm and of fine appearance. Blossomed June 23, 1902, first ripe fruit July 25, last ripe, August 20.

Columbian. The tall canes had been tied to wires early in winter to keep the snow from breaking them down. None were frozen back and until ripening time the canes were loaded with fruit. Blossomed June 27. First ripe fruit August 1, last ripe, August 27.

Older. This variety suffered more from dry weather than the other two. The fruit is of good size, round oblate, not very firm but sweet and of excellent quality. Blossomed June 16. First ripe fruit July 24, last ripe, August 20.

ORCHARD.

The great depth of snow during the preceding winter of 1902 caused the disfiguring and breaking down of nearly 150 trees, especially those growing on the north side of an elevation running partially through the orchard, the snow having drifted to a depth of 6½ feet, thus almost completely burying some of the young

trees. Those entirely broken off and the worst disfigured were replaced early in spring by stock upon which the old varieties will be grafted next spring. Three sprayings with Bordeaux mixture and arsenic were given and insects were not bothersome during the season except the apple tree aphis which proved almost invulnerable to the action of tobacco water which was used twice. The sprayings did but partially subdue the scab which appeared early in the season upon the leaves of Flemish Beauty pear trees, and no better results were obtained against shot hole fungus which affected most of the plum trees, though these trees had been given an extra spraying before the buds opened, and one after blossoming. While pruning trees early in April, some inoffensive small, dry leaves were seen clinging to the small limbs of apple trees. Their peculiar shape attracted attention, the leaflets being rolled up in a way which in shape made them appear as miniature blossoms of the Indian turnip, and the base of the leaf stalk being invariably attached just below a bud by means of silky threads wound around the limbs. Each leaflet was found to contain an emaciated and almost lifeless larva, and Prof. R. H. Pettit, to whom specimens were sent, described them as Basilarchia arthemis (banded purple) and as not known to be injurious to fruit trees. The latter statement, however, was not considered satisfactory, since the peculiar manner of attaching the leaves with the apex invariably pointed towards a bud, appeared to have been done for a well defined purpose. During the first warm day when the buds had just begun to open, one of the larva was seen to chew up the nearby freshly opened bud. When a second larva was found to destroy a bud three or four inches away from the rolled up leaf which was then empty, and the intervening buds showed that they had been destroyed within a few hours, there was no further room for doubt as to the nature of the larvae, especially when no other larvae could be found upon the same limb, and the remaining buds were found to be in good condition. A hurried harvest of hundreds of the rolled up leaflets followed, and the injury from the arthemis was practically at an end.

Several species of loop worms became numerous during midsummer when spraying had been stopped. Most of the worms, however, soon disappeared, being evidently killed by Braconids which more or less covered most of the worms.

Close attention and a persistent warfare of nearly two weeks early in spring, prevented damage from the cherry beetle (Calerucella cavicollis), the worst insect pest in this region. The beetle is as voracious as the potato bug, which it closely resembles in habits, if not in size or color. Emerging from the ground as soon as the cherry leaves begin to open, and with an appetite sharpened by a whole winter's fast, a dozen beetles will often make short work of the tender foliage of a young tree. As cherry trees blossom soon after the leaves begin to develop, spraying against the beetles would hardly be countenanced by the true orchardist. Various other means of destruction suggested by Prof. Pettit will be experimented upon hereafter. Meanwhile the injury during last spring was averted by catching the beetles as they were climbing up the trees, and by digging them out of the ground at the base of the trees; the beetles hibernating 2 to 4 inches below the surface, and not further than three to four inches away from the trees. From 58 to 92 beetles were dug out from under each tree, and almost as many were caught climbing up. Over 4,000 beetles and their ultimate progeny were thus destroyed and none were seen during the rest of the season.

As elsewhere, Gummosis affects the sweet cherries. With only two varieties on hand, and only 2 trees of each, it is somewhat difficult to try experiments which would lead towards the discovery of a remedy. As a result of experiments made in a small way during the past two seasons, a simple remedy would appear to be of some benefit, even though little has been possible towards finding a preventative. Presuming, and no doubt correctly, that fungus and other diseases find a ready means of entrance through the openings caused by the freshly exuding gum, and that the souring of the gum materially retards, if not prevents the mending of the broken tissues, the bark was slit open on one of the Gov. Wood trees, as soon as gum was seen to exude, and the cavity filled with soft clay. In case of heavy rains following, the operation was repeated, and the tissues were soon found to be healing over rapidly. The other tree was left untreated, and at this, the end of the second season, there is a marked contrast between the two trees, the untreated tree being nearly one-half inch less in diameter, and the top not being half as well developed.

The growth of all cherry trees has been remarkably thrifty, many trees measuring 8 inches in circumference. Since only one year has elapsed since they have been set out in the permanent orchard, it was not deemed advisable to let them

ripen more than a very few cherries. Though the May and June frosts killed many blossoms, thinning out was necessary as soon as the fruit had set.

Of the plum trees, the Stoddard is proving one of the hardiest and shows an ability to bear earlier than the other varieties. The fruit clung to the trees almost until ripening time, but fell off, partly owing to high winds which raised havoc with most varieties, and partly owing to the inability of further spraying against shot hole fungus. Several other varieties blossomed but no fruit set.

Following are the noteworthy varieties of cherry trees which ripened fruit:

Gov. Wood. A sweet variety. Blossomed May 24. Fruit ripened July 29. A vigorous, upright tree with stout spreading branches. Fruit medium size, heart shaped, light crimson, cavity of medium depth. Flesh very tender and of excellent, mild flavor. Stem unusually long and slender, frequently exceeding 2 inches; the fruit, however, being well protected by the extra large size of the leaves.

Dyehouse. A vigorous tree of spreading habit. Blossomed May 22, ripened July 25. Fruit pale red, medium size, round, slightly oblate; cavity broad with stout stem 1 to 1¼ inches long. Flesh tender, juicy, acid and of good flavor.

Ostheim. A stout tree of dwarfish habit, with upright branches and drooping twigs. Likely to prove the best yielding variety. Fruit medium size, round, dark red. Cavity narrow and shallow with stem of medium size, averaging 1½ inches long. Sub-acid and of superior flavor. Flesh tender and quality excellent. Blossomed May 21, fruit ripening July 28.

Early Richmond. A rapid growing tree of spreading habit, though somewhat more compact than Dyehouse. Fruit medium size, roundish, dark scarlet; cavity narrow and deep with long slender stem. Flesh soft, juicy, acid. Blossomed May 22, fruit ripening July 15.

Montmorency. A strong growing tree with round, spreading head. Fruit large size and red amber colored; round, oblate; cavity broad, deep, with stout stem seldom exceeding 1 inch long. Flesh tender, sub-acid and of very best quality. Blossomed May 23, ripening July 30.

Large Montmorency. Tree somewhat larger and more spreading than the last. Fruit practically the same, though perhaps a trifle larger. Blossomed May 24, ripening July 31.

English Morello. A small, vigorous tree, bearing evidence as a heavy yielding variety. Fruit small to medium, roundish, globular; cavity narrow and very shallow with long, slender stalk. Color dark purple; flesh coarse, moderately acid and slightly astringent. Blossomed May 23, ripening August 11.

Brusseler Braune. A strong, upright growing tree and the only one among the sour varieties showing a tendency of being subject to "gummosis." Fruit large, roundish, slightly oblong; cavity very narrow and moderately shallow with stout but very long stem, averaging 2 to 2½ inches. Color brownish black; flesh tender, juicy, red, acid, of excellent flavor and superior quality as one of the latest varieties. Blossomed May 23 and ripened August 17.

Wragg. A vigorous tree of somewhat spreading habit. Fruit large, roundish, somewhat resembling Brusseler Braune in shape, with stem a half inch shorter. Color crimson black. Flesh firm and of excellent flavor, acid and slightly astringent. Blossomed May 23 and ripened August 8.

All varieties of pears and apples made good progress, and the many varieties on trial are all apparently adapted to the climate.

The soil around the grape vines was infested with cutworms. The young shoots were cut off as fast as they appeared above ground, and several vines failed to recover from the damage, dying before the true cause was discovered and the cutworms disposed of. Damage from late frosts was averted by inverting small wooden boxes over the vines during the night, and the new growth of the vines which survived the injuries from cutworms, averaged 4 feet at the end of the season. The vines were pruned at the beginning of winter, and the former practice of giving no winter protection was adhered to.

CHEESE PROBLEMS.

JOHN MICHELS, B. S., A., INSTRUCTOR IN CHEESE AND BUTTER MAKING.

Special Bulletin No. 21.

I. Relation of Yield of Cheese to per cent of Fat in Milk.
II. Paraffining Cheese.
III. Cheddar vs. Stirred Curd.
IV. Cheese Ripening as Affected by Temperature and Moisture.
V. Sage Cheese.
VI. Gassy Milk.

SUMMARY.

I.—The measure of the value of milk for cheesemaking is the fat content. When normal milk is furnished the factory, with fat content between three and five per cent, the amount of cheese made per hundred of milk varies very nearly with the per cent of fat.

II.—Dipping cheese in hot paraffin for a moment, thus coating it with a thin, impervious coat materially lessens shrinkage, prevents the formation of an undue amount of rind and prevents molding. For best results the paraffin should be at a temperature higher than it can be carried using steam, hence a gasoline burner is suggested. The best temperatures lie between 240° and 250° Fahr. The best paraffin for this purpose has a melting point somewhere between 130° and 135° F.

The amount of paraffin required for a cheese weighing 44 pounds is one quarter of a pound.

Cheese should be treated within two to twelve hours after leaving the press.

The shrinkage is less than one quarter as great in paraffined cheese as in untreated lots. This means a minimum saving of $175.00 per season in a factory with an average daily output of 400 pounds.

III.—More water can be incorporated in cheese when the curd mill is used and the curd matted than by the stirred process but a water content of over 38 per cent is objectionable even in a quick curing cheese.

IV.—Cheese with a moderately high water content will cure better at 60° than at 38°; but where the water content is excessively high or where the milk had a bad flavor 38° is recommended as a ripening temperature rather than 60°.

V.—The sage flavor is given to cheese either by adding sage tea or sage leaves to the curd before salting. For the tea six ounces of sage are required per thousand pounds of milk, while when the leaves are used but three ounces are required.

I. RELATION OF THE YIELD OF CHEESE TO THE PER CENT OF FAT IN MILK.

It is the common practice in Michigan cheese factories to pay a fixed price per hundred for milk regardless of its richness in fat. There would be nothing to criticise or condemn in this method were it true that each hundred pounds of milk made as much cheese as every other hundred pounds brought to the same factory. If it were true that a given weight of three per cent milk yielded as much cheese of as good quality as an equal weight of five per cent milk the farmer having a herd of cows producing the richer milk would have no reason to complain. No injustice would be done him. A host of careful experiments in New York, Wisconsin and other states and in Canada have shown that the amount of cheese made from milk is quite accurately measured by the amount of fat the milk contains and that therefore the usefulness of the Babcock test in fixing the relative values of milk is not confined to the creamery but should be extended to the cheese factories as well.

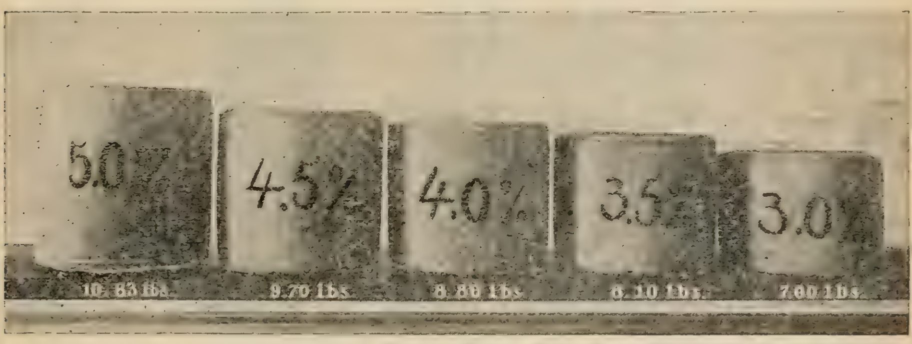
It is not the purpose of this bulletin to republish the results of work along this line done elsewhere nor enter into a full discussion of the necessity of the Babcock test in cheese factories if anything like justice is to be done to the patrons, but simply to call attention to some work done at this station, the results of which confirm the earlier conclusions.

The milk crom the college herd was used in the experiments. The cows were so grouped as to allow delivery at the cheese room of milk testing 3%, 3.5%, 4%, 4.5% and 5% fat. Eighty-five pounds of each sample of milk were used with results indicated in the following table:

Pounds of milk.	Fat, per cent.	Pounds of cheese.	Pounds of cheese from 100 pounds of milk.	Value at 11 cents per pound.	Pounds of cheese from one pound of fat in original milk.
85	3	7.00	8.235	$0.905	2.74
85	3.5	8.10	9.53	1.048	2.72
85	4	8.80	10.353	1.139	2.59
85	4.5	9.70	11.41	1.255	2.54
85	5	10.83	12.74	1.40	2.55

It is manifestly unfair for the factory to pay as much for a hundred pounds of milk from which but 91 cents worth of cheese is made as for another hundred pounds from which the cheese is worth $1.40, yet that is exactly what is done when the milk is pooled and the same price per hundred is paid regardless of quality.

While it was true that a pound of fat in the original milk did not make exactly the same amount of cheese in each case, yet payment on the basis of the fat content would not result in such broad injustice as is inevitable where the milk is pooled. If the milk had been paid for at the rate of twenty cents a pound for the fat content, the milk required for a pound of cheese would have cost $.0728 in the



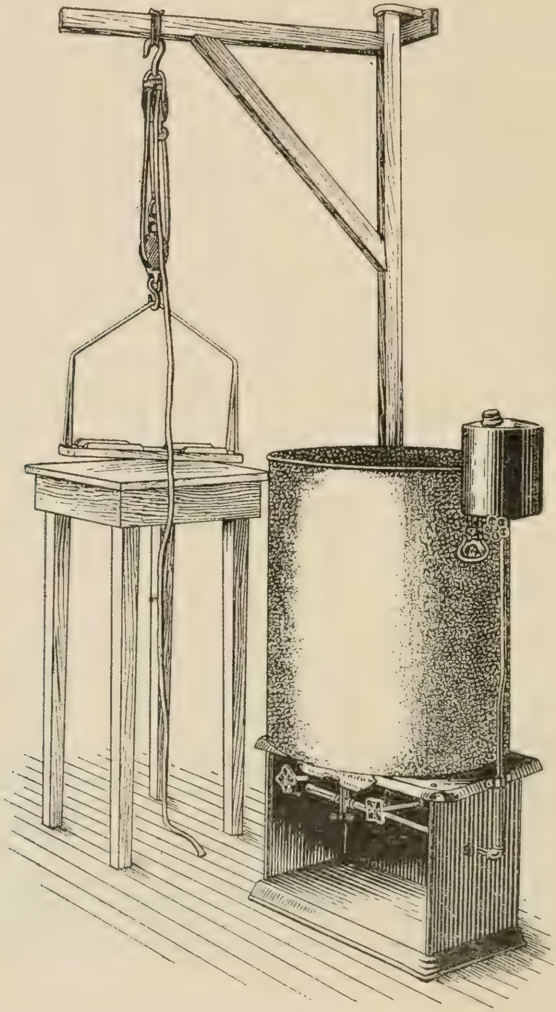
case of the three per cent milk and $.0785 in the five per cent milk. If all the milk had been bought at the uniform price of a dollar a hundred then in case of the three per cent milk, the amount necessary to make a pound of cheese would have cost 12.13 cents and in the five per cent milk but 7.85 cents, a much wider variation than by payment according to the test.

II. PARAFFINING CHEDDAR CHEESE.

The subject of cheese paraffining is receiving much attention by dealers, especially those interested in the storage of summer-made goods for winter consumption. During the past season the Saginaw Produce and Cold Storage Co. of Saginaw, Michigan, has stored a considerable quantity of cheese so treated. After

five or six months the cheese had a very fine flavor, good texture, scarcely any rind and absolutely no mold.

To study the method of applying the paraffin, the cost of the operation and its economy, some experiments were conducted at the College and at several cheese factories.



To secure a perfect, permanent and impervious coating over the entire surface, the cheese is dipped for a moment in liquid paraffin. Heretofore the paraffin has been heated by steam or hot water and it has been difficult if not impossible to secure a temperature higher than 200° Fahr. Where the cheese was dipped at this low temperature there was a manifest tendency for the coating of paraffin to crack and even peel off. A double gasoline burner was therefore tried and the temperature raised as high as 266°. Repeated tests at various temperatures seemed to indicate that the best results are obtained between 240 and 250° Fahr. In fact in no case where the dipping was done at these high temperatures, did the coating peel off.

The experiments show that a thin coat of paraffin is all that is needed. To secure it and to economize material and time, the apparatus illustrated by the cut is suggested.

The cheese is supported on a wooden holder so constructed as to touch it at four points only thus making no large breaks in the coat of paraffin. The small double pulley is quite essential so that the cheese may be lifted out of the hot liquid after a moment's immersion and may be held for a few seconds close to the surface that the surplus paraffin may drain off the sloping base of the cheese holder. The derrick permits the ready movement of the cheese from the table to the can and back. The whole apparatus should not cost over ten dollars.

It was found that dipping the cheese at the high temperature suggested, not only caused the paraffin to set better but less of it was required as indicated in the following table:

Cheese, pounds.	No. of trials.	Temp. of paraffin.	Paraffin.
44	5	194° F.	0.256 lbs.
44	5	212° F.	0.250 lbs.
44	5	230° F.	0.250 lbs.
44	5	248° F.	0.238 lbs.
44	5	266° F.	0.210 lbs.

In the table below some of the data obtained with reference to shrinkage in the curing room with temperature of 66° Fahr. are presented:

Factory.	No. of trials.	Cheese, pounds.	Age at final weighing.	Shrinkage.	
				Paraffined, pounds.	Unparaffined, lbs.
College	7	7.5	42 days	0.14	0.65
Perry	12	44	4 days.	0.06	0.32
Perry	2	44	7 days	0.12	1.25
Shepardsville	4	44	7 days	0.12	0.95

The differences in shrinkage were least in the Shepardsville factory, but even there the treated cheese shrank so much less than the untreated that for a single cheese weighing 44 pounds there was a saving of .82 of a pound in a week or 1.86 pounds per hundred. Valuing cheese at 9 cents per pound this would mean a saving of $.167 per week per hundred pounds of cheese.

It was found that paraffin would stick rather better to the cheese itself than to the cloth circles hence they were omitted, adding that small item to the saving in the matter of shrinkage. It is safe to estimate therefore the net economy on the side of the paraffined cheese as between fourteen and fifteen cents per hundred pounds of cheese, since it costs less than five cents per hundred to paraffin.

Another item to be considered in this connection is the saving in the matter of rind. Where a cheese has been paraffined soon after leaving the press there is scarcely any waste as the rind is very thin. In the following table there is presented, besides the weight of rind on paraffined and unparaffined cheese, the shrinkage when kept in cold storage at 38° F. for 38 days:

	Initial weight, pounds.	Final weight, pounds.	Shrinkage.			Loss in rind, per cent.
			Pounds.	Per cent.	Rind, lbs.	
Paraffined	7.22	7.00	.22	3.05	.22	3.14
Unparaffined	7.34	6.93	.41	5.58	.85	11.56

RELATION OF TEMPERATURE TO SHRINKAGE.

To determine the shrinkage of paraffined cheese at different curing temperatures several, seven pound, Young Americas were cured at 60° and duplicates at 38°. After twenty days the former had shrunk .14 of a pound each and the latter .1 of a pound. In another trial comparison was made between treated and untreated cheese with results reported in the next table which gives the shrinkage after 18 days:

	Paraffined.		Unparaffined.	
Temperature	65° F.	38° F.	65° F.	38° F.
Initial weight	7.50 lbs.	7.22 lbs.	7.19 lbs.	7.35 lbs.
Final weight	7.37 lbs.	7.22 lbs.	6.87 lbs.	7.30 lbs.
Shrinkage	0.13 lbs.	0.00 lbs.	0.32 lbs.	0.05 lbs.

Coating the cheese with paraffin proves an almost complete preventive of mold in curing and storing. Of duplicates, one paraffined and the other not, the latter, after a few days in the curing room, would gradually be covered with mold while the former remained apparently as clean as when first made.

As to the age of cheese at which the paraffin should be applied there seems a well defined difference between the firm sorts and the soft, quick-curing average Michigan cheese. With the former very satisfactory results were obtained by applying the paraffin soon after taking from the press. With the softer sorts it was more satisfactory to defer the application for several hours or until the surface was entirely dry.

Paraffined and unparaffined cheese were examined from time to time and, while in general there was little difference to be noted in quality, still there were cases in which the treated lots were superior in both flavor and texture. This was more frequently noted in the firmer kinds.

Taking all these matters into consideration it is safe to recommend the practice of paraffining cheese to Michigan factories, especially to such of them as strive to make a quick curing cheese. It will hasten the ripening by retaining moisture; will make the ripening more uniform and will save waste in the rind and in shrinkage. It will save fully $175.00 per year in a factory turning out 400 pounds of cheese per day.

IV. CHEDDAR VS. STIRRED CURD.

Inasmuch as the curd mill is not much used in the manufacture of Michigan cheese, and further, since this cheese is somewhat moist and more porous than Wisconsin and New York Cheddar, a series of experiments was made to determine the relative porosity and water content of cheese made by the two processes.

Four cheese were made in each trial, as follows:

The milk after being ripened to the proper point was divided between two vats, treated as nearly alike as possible until after the removal of the whey, when the curd in one vat was hand stirred for one-half to one hour and then salted, while the curd in the other was matted, cut and salted after one hour. Two cheese were thus obtained from each vat in which the acidity by the hot iron test before salting, varied from ¼ to ¾ inch in the various trials. Immediately upon leaving the press the water content of the cheese was determined by the method employed by the Association of Official Agricultural Chemists. (Bulletin No. 46 Revised edition, Division of Chemistry, U. S. Dept. of Agriculture.)

In the following table will be found the results showing the per cent of water incorporated in the cheese by the stirred and cheddar processes respectively:

	Per cents of water.									
Trial.	1	2	3	4	5	6	7	8	*9	10*
Cheddar....	40.85	41.34	41.22	42.38	46.10	42.51	43.48	41.46	42.15	40.36
Stirred.....	39.53	37.49	40.12	40.40	44.24	40.51	43.34	38.67	38.85	36.46

* Stirred one hour.

Remembering that the cheese were made alike in every respect up to the time of the removal of the whey, differences in water content noted must be ascribed to differences in treatment which the curd received after such removal.

It will be noted that where the stirred and cheddar cheese were both salted at the same time, i. e., one hour after dipping, the latter contained a great deal more water than the former. Inasmuch as the common practice with Michigan cheese makers is to stir the curd for a half hour only between dipping and salting, this time was adopted with the stirred cheese rather than one hour which was the time uniformly used with Cheddar cheese, yet the latter always contained the larger per cent of water.

From the table below, it will be seen that the yield was also a little greater with the cheddar than with the stirred process. Since the losses in manufacture were practically the same, this difference in yield must be ascribed to the difference in the water content:

	Weight of cheese in pounds.									
Trial.	1	2	3	4	5	6	7	8	9	10
Cheddar....	16.75	15.75	15.40	17.60	17.00	16.75	17.25	15.75	17.75	16.50
Stirred.....	16.75	15.40	15.40	17.40	16.75	16.75	17.25	14.75	16.75	15.50

To secure a fairly moist cheese with the curd mill, care must be taken not to stir the curd too dry before allowing it to mat, furthermore the matting must be done as quickly as possible by frequent and deep piling of the curd, keeping the temperature as nearly as possible at 98°.

An examination of the cheese showed that the cheddar or curd mill process has a tendency to produce a somewhat closer texture than the stirred method, though a cheddar properly firmed with a small amount of acid (¼ to ½ inch) before salting, will produce a porous cheese, especially if ripened at a temperature of 60° or above.

In the stirred and cheddar cheese, with a fairly normal per cent of water and where the differences in water content were minimum, no difference was noted in the flavor. In several cases however where the water content was high and the differences a maximum, the cheese with a higher water content had the poorer flavor, as might naturally be expected.

The curd mill is therefore to be recommended if it is desired to make a moist, quick ripening cheese, because it is absolutely necessary in combating gassy curds and securing uniformity in the product from day to day.

The question of the amount of moisture that may be incorporated without injuring quality is an important one. With this question arises another as to the relation of curing temperatures to the water content.

In the conduct of the experiment just described, a double set of cheese was made to permit their use in this test. As soon as taken from the press, one stirred and one cheddar were placed in cold storage at a temperature of 38° while duplicates were ripened in the ordinary curing room with temperature at 60°. The water content of the cheese was set forth in a previous table. Repeated examination showed that all containing over 38 per cent of water whether ripened in an ordinary curing room or in cold storage, developed a very undesirable pasty texture. Moreover the cheese ripened at 60° developed a very strong flavor which increased with age. This strong flavor was absent in the cheese ripened at 38°.

For the manufacture of a rather quick ripening cheese, one suitable for home consumption, a water content of from 36 to 38 per cent seems best, when the ripening goes forward at ordinary temperatures while 36 per cent appears to be most favorable for ripening at the low temperatures. It was quite clear that cheese ripened at ordinary temperatures would stand at least two per cent more water than those ripened at low temperatures.

So far as flavor is concerned, cheese with an abnormally high water content, or made from bad flavored milk will develop a better flavor at low temperatures than at higher ones. On the other hand a cheese with an abnormally high water content will develop a better texture at high temperature than lower. Owing to the excessively mild flavor produced at low temperature, the highest as well as the lowest scoring cheese were those ripened at ordinary temperatures.

V. MANUFACTURE OF SAGE CHEESE.

The manufacture of sage cheese is now carried on in a limited way only and is restricted to certain localities, yet a great many people are exceedingly fond of it, and will pay from one to two cents per pound more for it than for ordinary cheese.

Sage cheese is made exactly the same as cheddar differing from it only in possessing a sage flavor which is imparted in one of three ways: (1) By adding the sage extract or tea to the milk; (2) by adding the extract to the curd before salting; (3) by adding the sage leaves to the curd before salting.

The addition of sage tea or extract to the milk is objectionable, requiring too much sage, 10 to 12 ounces for one thousand pounds of milk.

The addition of extract to the curd gave entirely satisfactory results when the extract was not too dilute and when added very cautiously to prevent waste. The amount of sage required was six or seven ounces for the curd from a thousand pounds of milk.

The most satisfactory method was the addition of the sage leaves to the curd requiring the least amount of sage, three ounces being sufficient fo· the curd from a thousand pounds of milk. By this method the sage is weighed, the st ms all picked out and the leaves finely powdered. The powdered leaves are added just before salting.

VI. GASSY MILK.

No trouble is more frequent in a cheese factory and none more difficult to handle than gassy milk and consequent floating curds. Observation shows that a great share of the cheese made during the summer months is of inferior quality because the action of the gas germs has not been prevented. In the educational

scoring tests which take in cheese from all parts of the state, by far the most common fault was that caused by gas germs. These germs impart a very strong and undesirable flavor and besides make the cheese full of holes, openings about the size of a pinhead, hence the common name "pinholey." Such cheese tends to become dry and corky, a condition which, combined with the peculiar flavor and texture, renders the cheese practically worthless.

A good way of fighting this evil brought about by the gas germs in milk is to use a fine flavored sour milk, usually called a starter, using about four pounds of it to a hundred pounds of the infected milk. Gas germs cannot live and grow in the presence of overwhelming numbers of acid germs. On the other hand the acid germs cannot grow rapidly in the presence of large numbers of gas germs. This is why it is so difficult to develop acid in gassy curd. If the milk is excessively gassy the following treatment is suggested:

Use about four pounds of starter for 100 pounds of milk; develop a little more than the usual amount of acid before setting; cut fine and heat quickly to 100° or above if necessary. Remove whey when the curd shows one-fourth inch acid; place curd upon the racks and allow it to mat thoroughly by frequent turning and deep piling, keeping the temperature constantly at 98°. Cut the curd and air thoroughly by frequent stirring until gas holes flatten out and the gassy flavor disappears. This may require from two to four hours. Wash curd with clean warm water before salting. The following pointers on starters are submitted here as of value in this connection:

A good starter is a clean flavored batch of sour milk or skim cream.

Starters are used to overcome bad fermentation in milk and cream.

There are two kinds of starters: (1) natural; (2) commercial.

A natural starter is ordinary sour milk or skim milk.

Commercial starters are made in laboratories by selecting and breeding the right kind of germs.

Commercial starters are giving very good satisfaction and their use is rapidly increasing.

Among the important of these starters or cultures may be mentioned:

1. Douglas Culture, manufactured by O. Douglas, Boston, Mass.
2. Keith Culture, manufactured by S. C. Keith, Jr., Charlestown, Mass.
3. Hansen's Culture, manufactured by Hansen's Laboratory, Little Falls, N. Y.

Commercial starters are prepared as follows:

Heat four pounds of milk, or preferably skim milk, to 160° F. Keep at this temperature 10 to 15 minutes, then cool quickly to 70° F. Now introduce bottle of Commercial Culture and let stand till milk has just thickened. This thickened milk is the starter.

The starter is carried on from day to day as follows:

Heat and cool milk as explained above (pasteurize) and introduce into it enough of the four pounds of starter already made to sour the milk in 24 hours at a temperature of 70° F. The amount required is generally 3 to 4 per cent; that is to every 100 pounds of pasteurized milk we must add 3 to 4 pounds of old or mother starter. The remainder of the old starter is added to the milk used for cheese making.

By always saving a little of the old starter and putting it into milk newly pasteurized (heated and cooled) the original ferment can be carried from one batch of milk to another for weeks.

THE CROP OF CORN.

BY JOS. A. JEFFERY.

Special Bulletin No. 22.

In studying the corn crop it is worth while to form some idea, first of all, of its importance and magnitude, to learn if possible the meaning of the expression "King Corn" and "Corn is King."

Corn is grown on every continent but in greatest quantities on thé continent of North America.

In 1901 the corn crop of the world was 2,327,894,000 bushels. In 1902 it was about 3,000,000,000. In 1902 the crop of the United States was 2,523,648,312 bushels—more, it will be seen, than the world's crop of the year before and more than five-sixths of the crop of 1902.

Generally speaking the United States produces about three-fourths of all the world's yield.

Our closest competitors among the nations are Hungary and Roumania in Europe. Each grows about one-tenth as much as the United States. Argentina in South America is becoming a corn producing nation and promises to become an important competitor.

Question 1. If the whole crop of 1902 could be placed in a crib covering one section of land (one mile square), how high would the walls of the crib need to be to hold the crop provided the crib should be just level full? Estimated 4,300 cubic inches to the bushel of ear corn.

Question 2. How high is the peak of your barn and how many times as high will this national corn crib be?

In the United States, Illinois, Iowa, Missouri, Nebraska, Kansas, Indiana and Ohio lead in the acreage and total yield of corn and together are known as the "Corn Belt." In 1902 they stood in the order named for yield.

In 1902 Michigan stood eigtheenth in the list of corn producing states. In 1901 we stood eleventh.

The average yields of the "Corn Belt" states for ten years are as follows:

Ohio	33.03 bu. per acre
Illinois	32.8 bu. per acre
Indiana	32.11 bu. per acre
Iowa	31.3 bu. per acre
Missouri	26.8 bu. per acre
Nebraska	23.62 bu. per acre
Kansas	20.25 bu. per acre
Average for belt for 10 years	28.56 bu. per acre

The average yield of corn for the United States for the past ten years is 23.9 bu. per acre.

It is interesting to note that the average yield of corn for Michigan for the same ten years is 30.91 bu. per acre and that its average exceeds the average of the corn belt and exceeds also the average yields of three of the corn belt states, viz.: Missouri, Nebraska and Kansas.

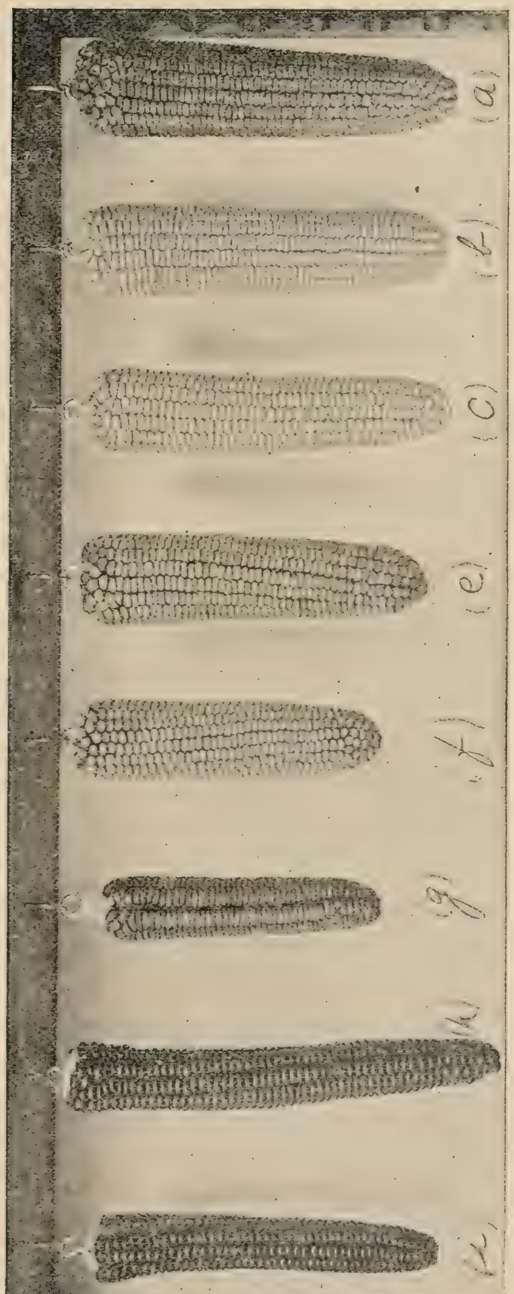
It is interesting also to know that Vermont leads all the states in average yield for the past ten years of 37.56 bu. per acre. Massachusetts stands a close second with an average yield for the same ten years of 37.32 bu. per acre.

South Carolina stands at the foot with an average of 9.13 bu. per acre for the same period.

Question 3. Why should Kansas give an average yield for ten years of 20.25 bu. while Michigan gives an average of 30.91 bu.?

Question 4. Why should Vermont lead all the states with an average of 37.56 bu.?

Question 5. Why should South Carolina give an average yield of 9.13 bu. only?


(a)
(c)
(e)
(f)
(g)

VALUE OF THE CROP.

The price of corn varies from year to year and through the year. For 1902 the average monthly price of corn on the Chicago market was 59 15-16 cents per bushel For the year 1897 it was 25½ cents per bushel.

In January, 1902, the wholesale price of corn reached 88 cents in Chicago, while in February of 1897 the price went as low as 20 cents or less per bushel.

Question 6. With the price of corn 60 cents per bushel, what would be the value of the crop of corn of 1902?

Question 7. Dividing the value of the crop among the 80,000,000 people of the United States, how much would each man, woman and child receive?

USES OF CORN.

The uses to which the crop is put may be roughly outlined thus:

1. Human Food,
   - Meal,
   - Special forms,
     - Flour,
     - Hominy,
     - Grits,
     - Flakes, etc.
2. Stock Food,
   - Grain—Whole or ground,
   - Ensilage,
   - Fodder,
   - Whole crop—green,
   - Manufactured by-products.
3. Manufactured,
   - Starch and resulting products,
   - Distilled and resulting products,
   - Corn stalks,
     - (*a*) Pith,
       - For naval use,
       - For manufacture of smokeless powder.
       - For manufacture of high grade varnish,
       - For manufacture of paper.
     - (*b*) Woody portions,
       - Food for stock,
       - Paper of low grade.

Wherever corn is grown it is used as a more or less important factor in the diet of the people.

In Mexico it constitutes the chief and indeed almost the only grain diet of the people.

The same may be said of the diet of the peasantry of Roumania and some other countries of Europe.

It constitutes the chief grain diet in certain sections of our own country while in all sections it is highly esteemed and takes a more or less important place in the dietary of the people.

The United States exports annually not far from two hundred million bushels of corn, England, Holland and Denmark being the largest buyers in the order named.

Of that remaining at home,

Perhaps forty million bushels are used annually by the starch and glucose factories and

Seventeen million bushels are used in the manufacture of distilled liquors.

Question 8. How many bushels of the crop of 1902 are left on the above basis for home consumption, for animal food, human food, and for seed?

It is impossible to say how much of the crop is used for human food. In 1900*

*U. S. census report of 1900

over 241,000,000 bushels of corn were ground in the mills of the United States, a portion of which was used for feeding stock.

Question 9. Approximately 94,000,000 acres were planted to corn in the United States in 1903. Supposing the amount of seed to plant the crop to be five quarts per acre and supposing 100,000,000 bushels of corn ground was used for human consumption, how much of the crop of 1902 was left for the live stock?

THE MANNER OF MAKING STARCH AND GLUCOSE AND THEIR BY-PRODUCTS.

Place a small handful of corn in a cup, pour boiling water in upon it and allow it to stand for 20 minutes. With a sharp pointed pen knife it is now an easy matter to remove (1) the outer covering or bran and (2) the germ, or "pit," and there will be left (3) the solid or starchy portion.

In the process of starch making the separation of the kernel into these three portions is the first step taken. In this case, however, the water used is not hot and the final separation is accomplished with machinery.

The separation accomplished, the bran is dried and offered for sale at from eight to ten dollars per ton for feed.

The germs are dried, ground and placed under a pressure of 4,000 lbs. per square inch. This removes 90 per cent of the oil. The oil is run into tanks, allowed to settle and then barreled. Corn oil brings from 4 cents to 5 cents per pound—30 cents to 40 cents per gallon.

Question 10. Corn oil is worth 4 cents to 5 cents per pound. Starch is worth 1 cent to 1 1-2 cents per pound. Can you suggest a way to increase the value of the corn you sell?

Corn oil is used in manufacturing paint, and by a chemical process is made into an artificial rubber which is mixed with real rubber to be made into vehicle tires, etc. Our exports of corn oil amount to about 4,000,000 gallons annually and a considerable portion of this is used in the manufacture of soft soap.

The portion of the germ remaining after the removal of the oil is sold for feed for live stock and is worth not far from $25.00 per ton at the present time.

The remaining portion of the corn is composed of starch and gluten. After crushing or grinding, the starch is washed out and dried. The gluten remains and is dried and may be purchased for feed for stock at about $25.00 per ton. It is the flesh and milk producing part of the grain and therefore is especially well fitted for feeding to dairy animals and to growing young stock.

The greater portion of the gluten and the corn bran are mixed and ground together in about the proportions in which they occur in the grain. The resulting product is gluten feed. It finds ready sale at from $17 to $20 per ton and appears to be highly prized by dairymen as a feed for milch cows.

Starch heated to 415° F. is converted into dextrine. Dextrine is used largely in the manufacture of mucilage and paste, the latter being used to prevent the running of the colors in the printing of calicos.

The mucilage found on postage stamps, envelopes and wrappers is made from a gum manufactured from starch.

Starch treated with dilute acid is converted into grape sugar, or glucose, most of which is sold in the form of syrup at from 1 cent to 1½ cents per pound wholesale. One factory alone converts 10,000 bushels of corn daily into glucose syrup. The sugar may be separated from the syrup and can be purchased upon the market.

Glucose sugar is not more than two-thirds as sweet as ordinary sugar.

Karo, the table syrup advertised so much at the present time, is composed of 90 per cent glucose syrup and 10 per cent cane syrup. It makes a very pleasant table syrup.

Question 11. The starch and glucose manufacturers claim that the farmers of Iowa e. g. can make money by selling a part of their corn to the glucose factory and buying back the by-products—bran, gluten, oil meal and gluten feed—to feed their stock. Can you discover any reason for believing the claim to be correct? What?

One bushel of corn produces
- 1.8 lbs of oil,
- 2.7 lbs. of oil meal,
- 36 lbs. dry starch,
- 7 lbs. of gluten and
- 5 lbs. of bran.

MANUFACTURED PRODUCTS FROM CORN STALKS.

In the corn belt very few of the corn stalks are fed. The corn is largely husked from the stalk and the cattle of the farm may be turned into the field to graize upon the stover and to pick up the ears that may have been left by the huskers.

In the spring the remaining stalks are broken down or broken down and cut into short lengths by a machine made for the purpose, and plowed under. In some sections the stalks are raked into piles and burned.

Of late years factories have sprung up where farmers are offered perhaps $3 per ton for their corn stalks. Here the woody outside portions of the stalks are removed, ground up and sold back to farmer or feeder at perhaps $6 per ton. The pith is saved. Portions of it are pressed into solid cakes to be placed between the outer and inner walls from somewhat below to a little above the water line of our great battle ships. If now in battle a projectile should penetrate the side of the ship below the water line, the moment the water began to enter the opening thus made it would come in contact with the pressed corn pith, the pith would swell and close, or seal up the opening and shut out the water.

Other portions of the pith are used for making
- A very fine quality of varnish,
- The best grades of smokeless powder and dynamite,
- A fine quality of paper similar to linen paper, and for
- Lining between the walls of refrigerators and refrigerator cars.

Space will not allow more than the mere mention of the fact that large quantities of corn are used in the manufacture of distilled products and special foods such as hominies, meals, flour, etc. But we have perhaps obtained some new idea of the magnitude and usefulness of this wonderful crop.

CORN PRODUCTION.

The corn crop will depend upon
1. The seed you use,
2. The soil,
    - (*a*) The kind of,
    - (*b*) Its condition as to
        - Moisture,
        - Temperature,
        - Ease of entrance of air. (All of which will depend not only upon the kind of soil but also the organic matter in the soil and upon the care given to its preparation.)
3. The care exercised in the preparation of the land,
4. Time of planting,
5. Care given to the crop after planting, and
6. Its place in the rotation.

SEED.

Some farmers are satisfied to select their seed corn from the crib in the spring. This is unwise and it cannot be expected that seed so selected can give the best returns in crops.

The seed can best be gathered from the standing stalk because here the stalk as well as the ear can be studied, and it makes a good deal of difference to the average Michigan grower whether the plant he is growing is of good fodder type or not. The things especially sought with us are:

1. Good ears—two on a stalk if possible,
2. Good fodder stalks, and
3. Early maturing.

Unless all of these are found in the plant from which we are gathering seed, it will not likely be found in the crop grown from the seed.

Question 12. Some claim that one good ear on a stalk is better than two, that the one will weigh more than the two. Test this next fall and report results.

Many farmers select seed at the time of husking saving the ears that to them approach their ideal of perfect ears.

Whatever the method of selecting, place the seed when selected where it will dry thoroughly and reasonably quickly.

Keep in a dry warm place till planting time.

There is much difference of opinion as to whether the tip and butt kernels should be planted.

Question 13. What is your opinion as to the planting of tip and butt kernels? Why?

SOIL.

The best soil for corn is a deep "open loam well supplied with organic matter." But whatever the soil it must be properly drained and well handled to obtain the best results. The corn crop requires a higher soil temperature than our other common cereal crops and also appreciates good soil ventilation, and must have plenty of moisture but not excessive moisture. It is said that it will send its roots to a depth of fifteen or twenty feet for water. Being a great rooter it must have plenty of room.

It is common practice to manure sod before plowing for corn. It is a question whether it would not be better to manure a year earlier and thus secure some of the benefits of the manure to the pasture.

PREPARATION.

Do not delay the plowing till you are just ready to plant the crop.

In all plowing the work should be done when the soil is in such condition of moisture that it will turn over mellow. One week of delay, and especially in sod, may make it impossible to secure, without great expense in time and labor, a mellow seed-bed.*

Do not be afraid of overworking the soil from the time it is plowed till planting time. Such working will

1. Improve the moisture conditions,
2. Promote the changes of plant food into soluble form,
3. Improve the temperature conditions, and
4. Destroy weeds whose growth has been promoted by previous stirring.

Experiment 1. Prepare two boxes or pans about three inches deep, fill each two inches deep with moist sand. Place in each one hundred kernels of corn from the same seed ear if possible. Now cover one-half inch deep with the same kind of sand and water from time to time. Place one box under the kitchen stove or in some very warm place, and place the other in a cool place, say in the cellar.

(a) *Count the number of corn plants up in two days, three days, four days and so on.*

(b) *Note how long before the first plant appears in each.*

(c) *Report results.*

TIME OF PLANTING.

Plant as soon as the soil conditions are favorable and the danger of severe frosts is past. I would rather run the risk of planting a little too early than a little too late.

THICKNESS OF PLANTING.

This must depend upon the use to which you wish to put the crop and also upon the strength of your soil. On ordinary soil in Michigan, the common method seems to be three stalks in hills three feet eight inches apart. Where the corn is planted for ensilage, it is a common practice to plant to have two stalks in hills

---

*See Article on Puddling of Soils, p. 85, Farmers' Inst. Report, 1902-1903.

fourteen to eighteen inches apart in rows three feet eight inches apart. Where corn hay is desired, the corn is sometimes drilled with an ordinary grain drill.

It is interesting to note that in some sections of the United States, notably in the South where the soil is poor, corn is sometimes planted in hills six feet apart each way.

THE BEST DEPTH.

The best depth is such that the seed will rest in moist soil. At the same time the nearer it can be to the surface and still have sufficient moisture, the more it will profit from the sunshine. These two conditions will depend upon your soil and upon your management of it. A greater depth is usually required in sands than in clay soils.

THE NEXT STEP.

After planting, harrow often enough to keep the surface of the soil mellow and to destroy weeds. This should be kept up till the corn is ready for the cultivator. The danger to the corn from the harrow teeth is not so great as would appear, but if the corn is planted in drills it is worth while to harrow crosswise rather than lengthwise of the rows.

THE BEST DEPTH TO CULTIVATE.

In cultivating, aim to keep the soil thoroughly stirred to a depth of two inches. The first cultivation might be deeper than this if the teeth are not run too close to the plants. If the ground has been previously well cared for, however, two inches is deep enough.

THE BEST CULTIVATOR.

That depends upon your soil. Use the cultivator that keeps your soil in best condition and freest from weeds. If you can accomplish this with the narrow shoveled cultivator, you have the added advantage of a smoother surface than could be gotten with the wider shovels and this means less loss of moisture by evaporation.

Question 14. Why?

HOW OFTEN SHALL WE CULTIVATE.

Experiment 2. (a) *Cultivate your field of corn the usual number of times.*

(b) *Set apart four rows and cultivate these once per week not over two inches deep till tasseling time.*

(c) *Set apart four rows and cultivate two inches deep once per week till tasseling time and then once per week for three weeks thereafter.*

(d) *Husk or cut and husk, the two inner rows of each of these four rows and also two rows adjacent to these and compare results. Or if you like, take five rods from each of the two rows for the test.*

(e) *Note the diffenrences in growth, appearance and yield.*

(f) *Report results.*

THE VARIETY OF CORN TO GROW.

Any variety that does well and gives reasonably good yields is all right.

Having selected your variety then proceed not only to give it a fair chance, but to improve it.

Strive:

1. To increase its productiveness both
    As to grain and
    As to fodder,
2. To shorten its period of maturity,
3. To develop an ideal ear,
    This means one
    (*a*) Of good length,
    (*b*) Well filled at tip and butt,
    (*c*) With straight rows set well together,
    (*d*) With deep kernels of rather uniform depth throughout,
    (*e*) With uniform color of kernel and cob,
    (*f*) Of high proportion of corn to cob.

Below is given a table showing ideals sought by corn breeders in Illinois:

	Length of ear.	Circumference of ear.	Proportion of corn to cob.	
			Corn.	Cob.
Ried's Yellow Dent	10 inches.	7 inches.	88%	12%
Golden Eagle	9 inches.	7 inches.	90%	10%
Riley's Favorite	9 inches.	7 inches.	90%	10%
Leaming	10 inches.	7 inches.	88%	12%
Boone County White	10 inches.	7½ inches.	86%	14%
Silver Mine	9 inches.	7 inches.	90%	10%
White Superior	8½ inches.	7 inches.	88%	12%
Average	9½ inches.	7 inches.	88½%	11½%

Experiment 3. Select twelve of the best ears from your lot of seed corn.

(a) *Determine:*

1. *Length of each ear and the average length of the twelve,*
2. *Circumference of each ear and the average circumference of all, (Measure the circumference one-third the distance from the butt to the tip.)*
3. *Weight of corn and cob and the average weights of these and express these relations in per cent.*

(b) *Report these results.*

Question 15. Do you find any ears that equal these ideals in every respect?

Question 16. Where do they fall most below these standards, if at all?

Question 17. Compare the longer ears with the shorter ones.

(a) *Which have the deeper kernels?*

(b) *Which have the larger proportion of corn to cob, by weight?*

PLACE IN THE ROTATION.

When the corn crop forms part of a rotation in which hay or pasture also forms a part, it seems to be conceded that its place is upon sod, that is, following hay or pasture.

The crop does especially well in this place for the reason, as all will agree, that there has been stored in the soil large quantities of food in the form of nitrogen (from the air if it was clover hay or pasture) and other materials in the form of extensive root growth and perhaps applications of manure which, decaying, become available for the growing corn crop.

Question 18. Did it ever occur to you that when you are pasturing a field, (1) *the only material you are removing from the field is a finished product in the form of meat or milk, and* (2) *practically all the manures are returned to the field at once and without loss?*

Suggestion. The most successful farmers in Michigan are the ones who are selling from their farms only finished products and who are practically returning their manures without loss to their fields.

It is probably not because of the accumulation of foods merely that the corn crop does so well after hay or pasture, but because of the physical condition which Nature through the combined action of roots, frosts and animal life in the soil, has succeeded in establishing in the short period of one or two years.

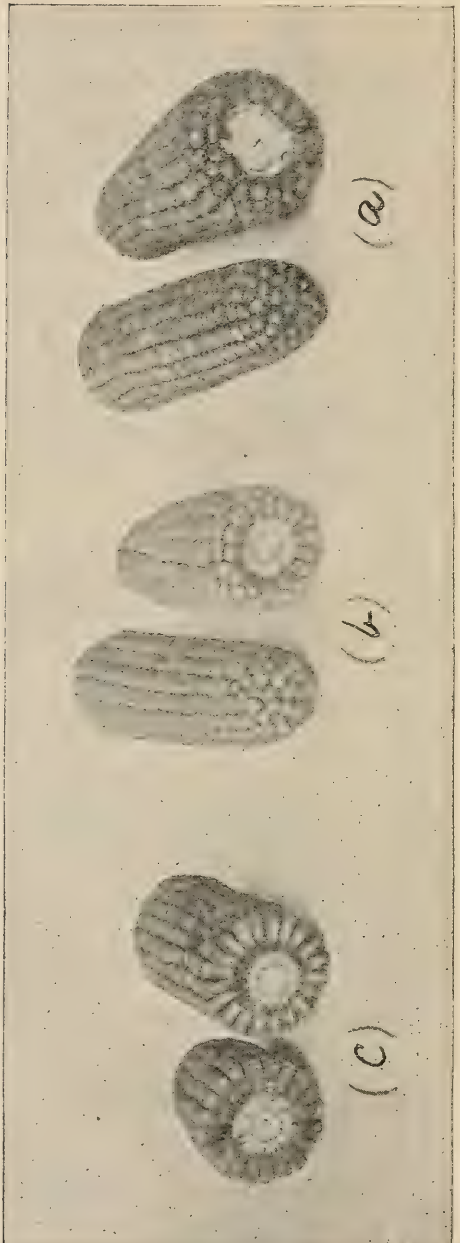
Suggestion. NATURE *is a great agriculturalist and withal a great teacher, if we would but learn from her.*

A STUDY IN EARS.

In cut 1,

(*a*) Is a very highly bred ear of Dent Corn from the Illinois Agricultural College and is valued at $2.50. It is nearly a perfect ear.

Question 19. Can you detect any defects as shown in the picture?


(a)
(b)
(c)

(*b*) Is a very good ear of Boone County White Dent selected from a bushel of seed purchased by us last spring from Mr. A. P. Grout of Winchester, Ill.

This corn was planted on the College Farm, May 21st, and on October 10th not an ear could be found of this variety that was beyond the soft dough stage, while our own varieties planted later than the Boone County White were ready for shock and silo three weeks before that time. The Stalks stood 25 per cent higher than those of our own corn.

Question 20. Can you account for this lateness of maturing of the Boone County White?

Question 21. Why on page 14 did we not advise sending away for some new and big variety of corn?

We shall continue to plant Boone County White from seed of our own saving and we are expecting that in time this corn will mature during our growing season, and we may take occasion to report results for the benefit of those who may be interested.

Question 22. Do you think we may expect any changes to take place in the shape, size, etc., of ear and stalk? What and why?

(*c*) Is an ear of Ayers' White Dent grown on our College Farm.

(*e*) Is an ear of Ideal Yellow Dent grown on the College Farm.

(*f*) Is an ear of Minnesota Yellow Dent grown by Mr. S. Friedenberger of Reed City, Mich. He has grown this variety for some years and is much pleased with it.

(*g*) Is an ear of Minnesota King grown in North Dakota and is probably the most satisfactory dent corn for that section of country. It matures in about 100 days from the date of planting. This quality has resulted largely from careful selection for a series of years.

(*h*) Is an ear of Smut Nose Flint grown at Vassar, Mich.

(*i*) Is an ear of a similar variety grown in North Dakota.

Observe the size of the North Dakota ears as compared with the others.

In cut 2.

(*a*) Represents well filled butt and tip of two ears of Ideal corn.

(*b*) Represents well filled butt and tip of two ears of White Dent corn.

(*c*) Shows the pieces of a typical ear of corn owned by a corn improvement enthusiast and prized very highly by him. It was broken by him only after much hesitation, to show the great depth of kernel to a large class of students before which he was lecturing. The broken ear was later given to the Department of Agronomy at M. A. C.

Note the great depth of kernel and how completely the kernels fill the space between the circumference of the ear and that of the cob.

A PRELIMINARY NOTE ON THE ASSOCIATIVE ACTION OF BACTERIA IN THE SOURING OF MILK AND IN OTHER MILK FERMENTATIONS.

BY CHARLES E. MARSHALL.

Special Bulletin No. 23.

While aiming specifically to secure further information concerning the "Aëration of milk," I isolated two species of micro-organisms from the milk of our college dairy which should be as diametrically opposed to each other as possible: one was a member of the group of lactic acid bacteria and the other belonged to the peptonizing class, constantly found in our college dairy milk and producing no acidity. Frequently I have brought two different species together in milk culture and have found an alteration in results which would be secured by either, but up to this time had not thought it worth the effort to combine a species of lactic acid bacteria with one of a class so different. It is not my purpose at this time to go into a detailed study of these two species of bacteria from a cultural and biologic standpoint, but rather to state as concisely as possible some of the conclusive experimental evidence which I have accumulated thus far. I hope to prosecute this work with vigor until I shall be able to give some idea of its extent and the practical bearing it may have.

The associative action is apparently indifferently understood in the fields of milk, fermentation, and pathogenic bacteriology, although it has been known for a long time that bacterial association is of variable and frequently of great importance in the application of bacteriologic knowledge. A pure culture may tell, if conditions are maintained, of the individual and isolated action of a bacterium, but by no means tells its action when brought into the influential company of another species of bacteria, especially if both are cultivated together in their natural environment. Analysis and synthesis should go together hand in hand, otherwise our conclusions might be like studying man apart from society in order to obtain his social relations.

The customary belief regarding lactic acid fermentation in milk is simple and has been so long established that modifications have not gained way. What we have to offer does not in any manner alter the understanding of the simple nature of fermentation of lactic acid under pure culture, but it has its bearing by its qualification of lactic acid fermentation in its application where other bacteria are involved. We have always assumed that the lactic acid bacteria would remain uninfluenced by other bacteria in milk or at most would only be retarded in a struggle and would gradually make their way by killing off or inhibiting the growth of other bacteria to the extent of their capacity to produce lactic acid from the lactose. With this working hypothesis, bacteriologists have made much advance, but have been unable to explain many phenomena attending lactic acid fermentation in milk other than to attribute them to possible deviations, variations, alterations, exaltations of virulence, due to the disturbances of the life per se of the lactic acid bacteria,

Let us designate our cultures as follows for the sake of brevity:

A=Lactic acid bacterium in litmus milk culture. When used as a starter in the dairy it was pronounced by Mr. Michels, the college dairyman, as excellent.

B=Peptonizing bacterium, eventually producing slimy milk.

A+B=Equal amounts of a 24-hour bouillon culture of A and B in the same amount of litmus milk employed in each culture A and B, 100 c. c. in each instance

There is no test applied which will yield more convincing proof than to watch the cultures closely for a period of several days, for in them may be read the entire history, although not furnishing any intimate knowledge of the changes.

Making cultures with definite amounts of cultural material used for inoculation into definite amounts of litmus milk, and placing these flasks at constant temperatures, the results ought to be very apparent, if carefully observed. If it is found later that more specific data are necessary for demonstration, we shall add the details in anticipated future articles on this subject.

The history of two gross test cultural experiments will perhaps be sufficient to

illustrate what I have already found to run very uniformly in a dozen or more trials.

The cultures used were made by inoculating 100 c.c. litmus milk in Ehrlenmeyer flasks of 250 c. c. capacity with very dilute cultures of A and B, made by diluting ½ c. c. bouillon culture in 100 c. c. of physiologic salt solution and using definite quantities of this for inoculating. A+B received of A the same amount as culture A, and of B the same as culture B, that is,

A=½ c. c. of diluted bouillon culture A, 24 hours old, in 100 c. c. litmus milk.

A=½ c. c. of diluted bouillon culture B, 24 hours old, in 100 c. c. litmus milk.

A+B=½ c. c. of diluted bouillon culture A, 24 hours old, +½ c. c. of diluted bouillon culture B, 24 hours old, in 100 c. c. litmus milk.

The gross changes in the milk may be indicated by the following scheme, temperature 20°-22° C. throughout:

20 hours after inoculation.

A=No change other than very slight reddening of litmus.

B=No change apparent in the milk.

A+B=Litmus redder than in A, but not so very marked. No change in milk.

44 hours after inoculation.

A=Litmus red. No other change in milk apparent.

B=No apparent change in the milk.

A+B=Litmus reduced except very thin red stratum of surface.. *Firm curd.*

68 hours after inoculation.

A=Litmus red throughout, no other change in milk apparent.

B=Very slight peptonization on immediate surface, but otherwise unchanged to eye.

A+B=Firm curd with whey separated. Litmus reduced except on immediate surface, where it is red.

92 hours after inoculation.

A=Litmus red throughout. No other change perceptible.

B=Milk peptonizing rapidly. Litmus is reduced in spots.

A+B=Firm curd with whey separated as in 68 hours. Litmus has become red throughout, probably through checked growth of micro-organisms and the permeation of curd by oxygen.

116 hours after inoculation.

A=Litmus red in upper half, lower half reduced. *Milk is beginning to lopper.*

B=Almost completely peptonized. Litmus reduced except in spots on surface, where it is still blue.

A+B=Same as at 92 hours.

141 hours after inoculation.

A=Curd separated from whey. Litmus reduced throughout except layer on surface.

B=Milk peptonized and slimy. Litmus blue on surface.

A+B=Same as at 92 hours.

If the loppering of the milk be any criterion to the change taking place in A and A+B, then there must be a difference of seventy-two hours for A+B first manifested signs of loppering at 44 hours after inoculation and A did not begin to lopper till the 116th hour after inoculation. By following the changes as recorded above, the differences are plainly evident.

In the second series the temperature varied between 23° and 24° C., two to three degrees higher than the preceding test. I am satisfied, even at this writing, that I am going to find material modifications with the changing of temperatures, but as yet I am not ready to report on the temperature studies with these two micro-organisms.

The second series:

23 hours after inoculation.

A=Litmus slightly reduced at the bottom, otherwise red. No change in the milk.

B=Litmus blue and unchanged.

A+B=Litmus completely reduced but becoming red on shaking a little. The milk is unchanged in appearance.

47 hours after inoculation.
A=Litmus reduced at bottom, red above. Milk unchanged.
B=Litmus blue and milk unchanged.
A+B=Litmus wholly reduced excepting a very thin stratum on surface. *Milk has formed into a solid curd.*

72 hours after inoculation.
A=Litmus red throughout. No apparent change in milk.
B=Litmus blue. Milk peptonizing slightly on immediate surface.
A+B=Litmus red throughout. Milk solid curd and whey separated.

95 hours after inoculation.
A=Litmus reduced at bottom, red above, and *milk beginning to lopper.*
B=Litmus partly reduced. Milk is peptonizing rapidly.
A+B=Same as at 72 hours.

The difference in time of loppering of A and A+B, forty-eight hours, is not so great in this test; however, in a dozen or more trials, identical in every particular, I have not found any passing these limits. It is fair to conclude that so far as the naked eye can note changes in litmus milk and milk without litmus, there must be differences in the cultures A and A+B and that A+B loppers much more rapidly than A. Further, when this is carried on in the same manner with milk taken from a cow by milking into a narrow mouthed sterilized flask and not sterilizing the milk at all, but simply making our inoculations as in previous cases, the results are in main the same, especially so far as loppering of A and A+B are concerned. I suspect, moreover, that bacteria present in such milk exert a marked influence, for I find that the courses run by the cultures A, B and A+B are in some details different in character. This is another open and suggestive field to be pursued at our first opportunity.

So constant and uniform have been the above results that after many trials I feel satisfied. Others whom I have incited to try have also met with like conclusions.

In the study of acidity of the same cultures, we find that B remains about the same for some hours after inoculation, but after standing several days becomes strongly alkaline, passing in the alkaline direction from the neutral point about as many degrees as A passes in the acid direction. Further than this, culture B need not be taken into account. The development of acid in cultures A and A+B may be advantageously added.

	Culture A.		Culture A+B.	
0 hours after inoculation........	18 degrees		18 degrees	
24 " " "	18 "		20 "	
44 " " "	28 "		64 "	loppered
68 " " "	40 "		74 "	
92 " " "	48 "		84 "	
116 " " "	52 "	loppering	93 "	
142 " " "	56 "		108 "	

The acidities in the above records verify the previous gross observations. It appears characteristic of A+B to make a very rapid rise in acidity immediately after twenty-four hours, while A progresses slowly and steadily. Another trial of acidity is added by way of confirmation, although all run very uniformly, much as in the above record.

	Culture A.		Culture A+B.	
0 hours after inoculation........	18 degrees		18 degrees	
23 " " "	24 "		32 "	
49 " " "	38 "		56 "	loppering
72 " " "	48 "		70 "	
96 " " "	56 "	loppering	84 "	
121 " " "	62 "		95 "	

The more rapid development of acid in A+B indicates the same results obtained from the gross tests and also points to a more rapid souring of milk in the combined culture.

The next natural question is, do the lactic acid bacteria increase more rapidly in the combined culture A+B than in A? Many counts of bacteria have been made in these cultures at different hours during the progress of the changes going on, and they all plainly show a more rapid increase of lactic acid bacteria in the combined A+B culture than they do in culture A. At the time of loppering, when the members show their greatest contrast, we find A : A+B=27 : 1614. Again, in another exhaustive count, the proportion stands thus: A : A+B=271 : 1537. These counts again bear out what has been stated heretofore.

It is also very noticeable that germs of culture B, as they develop in the combine culture A+B, die out completely but gradually before the 50th hour. In the first hours they predominate, but soon lose their ascendancy, leaving, however, a distinct influence in their wake and also a perceptible odor peculiar to this culture.

If this associative action is borne out with other similar micro-organisms when grown in the presence of lactic acid bacteria, the significance is great, for it will have a direct and practical application to dairy operations, in the matter of pure milk supply, souring of milk, milk fermentations, starters, and their management. Before further discussion, I am desirous of ascertaining how far-reaching this may be, and this can be accomplished by extensive experiments only. The conditions must now be greatly varied and the various germs usually met with in the dairy must be tested in this associative function before conclusions should be drawn for guidance.

Upon going to press we are able to say that two other micro-organisms have been met which have the same action as B when associated with this lactic acid bacterium; we have also met two others which retard the development of this lactic acid bacterium. Detailed studies will follow later.

Department of Bacteriology and Hygiene, Jan. 10, 1904. C. E. M.

MICHIGAN
STATE AGRICULTURAL SOCIETY.

MICHIGAN STATE AGRICULTURAL SOCIETY.

REPORT OF THE TRANSACTIONS OF THE SOCIETY FOR THE YEAR 1903, AND PROCEEDINGS OF THE WINTER MEETING, AND OTHER MEETINGS OF THE EXECUTIVE COMMITTEE PREVIOUS TO JUNE 30, 1904.

OFFICERS FOR 1903.

President—E. HOWLAND, Pontiac.
Vice President—STEPHEN BALDWIN, Detroit.
Treasurer—C. W. YOUNG, Paw Paw.
Secretary—I. H. BUTTERFIELD, Pontiac.

EXECUTIVE COMMITTEE.

Term ending January, 1904.

E. W. Hardy	Howell, Livington County.
Frank Maynard	Jackson, Jackson County.
H. R. Dewey	Grand Blanc, Genesee County.
H. H. Hinds	Stanton, Montcalm County.
F. E. Skeels	Harriette, Wexford County.
F. G. Jacobs	Pontiac, Oakland County.
W. W. Collier	Detroit, Wayne County.
Byron E. Hall	Port Huron, St. Clair County.
John Marshall	Cass City, Tuscola County.
Geo. H. German	Franklin, Oakland County.

Term ending January, 1905.

Eugene Fifield	Bay City, Bay County.
L. W. Barnes	Byron, Shiawassee County.
W. P. Custard	Mendon, St. Joseph County.
E. N. Ball	Hamburg, Livingston County.
W. E. Boyden	West Bay City, Bay County.
M. L. Dean	Agricultural College, Ingham County.
J. E. Rice	Grand Rapids, Kent County.
C. A. Waldron	Tecumseh, Lenawee County.
John McKay	Romeo, Macomb County.
John A. Hoffman	Kalamazoo, Kalamazoo County.

EX-PRESIDENTS.

Members Ex-Officio.

T. W. Palmer............................Detroit, Wayne County.
M. P. Anderson........................Midland, Midland County.
John T. Rich.............................Detroit, Wayne County.
I. H. Butterfield.......................Pontiac, Oakland County.

STANDING COMMITTEES AND EXECUTIVE SUPERINTENDENTS.

BUSINESS.

Eugene Fifield, John A. Hoffman, I. H. Butterfield.

TRANSPORTATION.

F. G. Jacobs, H. H. Hinds, E. W. Hardy.

PROGRAM.

H. H. Hinds, Geo. H. German, Secretary.

PRINTING AND ADVERTISING.

The Business Committee.

FINANCE.

John McKay, H. R. Dewey, Geo. H. German.

PREMIUM LIST.

C. W. Young, I. H. Butterfield, J. A. Hoffman, H. H. Hinds, John McKay, M. L. Dean, J. E. Rice.

RULES.

F. E. Skeels, W. P. Custard, L. W. Barnes.

RECEPTION.

Stephen Baldwin, W. W. Collier, M P. Anderson.

EXECUTIVE SUPERINTENDENTS.

General Superintendent—Eugene Fifield.
Chief Marshal—H. H. Hinds.
Cattle—W. E. Boyden.
Horses, other than speed—C. A. Waldron.
Horses, speed—Eugene Fifield.
Sheep—H. R. Dewey.
Swine—L. W. Barnes.
Poultry—C. A. Waldron.
Ass't Superintendent—Daniel Thomas, Pontiac.
Farm and Garden Products—E. W. Hardy.
Dairy, Bees and Honey—John Marshall.
Vehicles—J. E. Rice.
Agricultural Implements and Machinery—John A. Hoffman.
Main Building, Manufacturers and Miscellaneous—F. E. Skeels.
Art—Byron E. Hall.
Needle Work and Children's Work—Mrs. F. E. Skeels.
School Exhibits—Frank Maynard.
Horticulture—M. L. Dean.
Gates—W. P. Custard.
Police—E. N. Ball.
Forage—Geo. H. German.
Concessions and Privileges—F. G. Jacobs.
Transportation—F. G. Jacobs.

CAUCUS 1903.

A caucus of the Society was held at the office of the President on Wednesday, September 9th, at 4 o'clock p. m.

F. E. Skeels was made Chairman and I. H. Butterfield, Secretary.

On motion, the Secretary was instructed to cast the ballot of the caucus for E. Howland for President; S. Baldwin for Vice President; C. W. Young for Treasurer; I. H. Butterfield for Secretary.

H. C. Guillott was nominated for first member of Executive Committee; E. W. Hardy was also nominated. A ballot being taken, E. W. Hardy had 61, H. C. Guillott, 54. E. W. Hardy was declared nominated.

For other members of Executive Committee, the following were nominated without division: Frank Maynard, H. R. Dewey, H. H. Hinds, F. E. Skeels, F. G. Jacobs, W. W. Collier, Byron E. Hall, John Marshall, Geo. H. German.

On motion, adjourned.

At the annual election held on the fair grounds on Thursday, September 10th, the above named were elected to the respective offices named, each having 41 votes.

M. P. ANDERSON,
D. P. DEWEY,
Judges of Election.

THE FAIR OF 1903.

The annual fair of the Society was held on the grounds of the Oakland County Agricultural Society at Pontiac, September 7-11, inclusive. The weather was threatening, but no rain fell after Monday.

The attendance was large as is shown by the Treasurer's report. The exhibit was very large, the number of entries being greater than ever before.

ANNUAL WINTER MEETING OF THE EXECUTIVE COMMITTEE OF THE MICHIGAN AGRICULTURAL SOCIETY.

Held at the Hodges House, Pontiac, January 13, 1904.

Called to order by President Howland.

Roll called and the following members present: E. Howland, Stephen Baldwin, C. W. Young, I. H. Butterfield, E. W. Hardy, Frank Maynard, H. R. Dewey, F. E. Skeels, F. G. Jacobs, W. W. Collier, Byron E. Hall, John Marshall, Geo. H. German, Eugene Fifield, L. W. Barnes, W. P. Custard, E. N. Ball, W. E. Boyden, M. L. Dean, J. E. Rice, C. A. Waldron, John McKay, John A. Hoffman, and M. P. Anderson.

Quorum present.

On motion of Mr. Anderson, the regular order of business was suspended and reports of standing committees and superintendents were received as follows:

The Secretary reported as follows:

Gentlemen of the Executive Committee:

I have to report a very large number of entries at the last fair. All departments were well filled and as most of the superintendents know, the stalls and buildings were full to overflowing.

The total number of entries in all departments was 7,398. As a comparison I give the totals for a few years previous:

1902	6,342
1901	4,914
1900	4,413

A detailed statement of the entries in each class and division with the amounts offered and amounts awarded is herewith presented.

The total awarded is $13,818, and 50 diplomas. Of this amount $5,000 is appropriated by the State and $491 donated by the American Short Horn Cattle Breeders' Association. A few premiums remain unpaid, two or three small ones for which vouchers were returned from the postoffice unclaimed, and some in the horse department protested and not yet adjusted.

I suggest some changes in the premium list. There are some classes of live stock in which the Michigan premiums may well be cut out, making but one class and increasing the premiums to some extent.

The live stock associations desire that the rules be amended so that the same animal owned in Michigan may be allowed to compete with the open to all class also. Their representative will be here to present the request.

The matter of sales of live stock at the fair is being discussed by the Short Horn Breeders' Association, the Michigan Premium Stock Farm Company, and the Berkshire Swine Breeders, and the matter will be presented to you at this meeting.

The Michigan State Grange passed a resolution at its annual meeting, asking for headquarters for meeting and entertaining on the fair grounds.

An association has been formed in the Upper Peninsula of which Leo M. Geismar, Superintendent of the Upper Peninsula Experiment Station is Secretary, for the purpose of securing an exhibit of live stock, agriculture and horticultural products, at the State fair. We should co-operate with this association in this work.

The report was accepted and referred to the Finance Committee.

The Business Committee reported as follows:

Gentlemen of the Executive Committee:

The Business Committee submits its report of the business transactions of the Society, giving the expenditures in detail.

It will be noted that the expenditures have been greater than in 1902. Among the items that make the increase is rent of grounds, $1,143; booths erected, $818.76; work on grounds previous to the fair, $976.82; pipe for farm machinery, $163.75; lumber, $537.83; material used in 1902, $152.09. A total of $2,649.25 for labor and material, making with the rent paid, $3,792 more than the ordinary expense. There is on hand however of this lumber that cost $500—the booths cost $818.76 (which are reserved), pipe, $163.75, or a total of $1,482.51.

The committee was authorized to expend a total of $2,000 on the premium list. The total cost of the premium list and distribution was about $4,000, from which deducting advertising secured, $2,113, leaves a net cost of the 100,000 copies distributed throughout the State about $1,900, and the advertising, other than premium list, $4,438.80, or less than in 1902.

It is believed, however, that this unusual expenditure has so distributed knowledge of the society among the people of the State, that the benefit will extend to the present and even succeeding years.

It is the opinion of the committee that a large edition, finely illustrated, should be issued for 1904, believing that its value will warrant the expense.

The Business Committee have found it much more difficult each year to find attractions that would please the public, and be in reach of the limited amount of means we had placed in our hands for this purpose. We hope in the near future the Society will have a home of sufficient magnitude to call the eye of the State Legislature our way, and an appropriation given us, something near equal to our sister states.

EUGENE FIFIELD,
JOHN A. HOFFMAN,
I. H. BUTTERFIELD.

The report was accepted and referred to the Finance Committee.

Classified Statement of the Business Vouchers.

Date. 1903.	No.	Account Winter Meeting.	Amount.	
July 28	1	M. L. Dean, expenses	$4 49	
29	2	H. H. Hinds, expenses	8 34	
	3	Frank Maynard, expenses	5 15	
	4	H. R. Dewey, expenses	5 27	
	5	John Marshall, expenses	5 57	
	6	M. P. Anderson, expenses	10 19	
	7	E. N. Ball, expenses	4 00	
	8	W. E. Boyden, expenses	8 65	
	9	J. E. Rice, expenses	7 70	
	10	F. E. Skeels, expenses	11 35	
	11	John A. Hoffman, expenses	15 30	
	12	L .W. Barnes, expenses	4 70	
	13	E. W. Hardy, expenses	3 39	
	14	W. P. Custard, expenses	18 41	
	15	John McKay, expenses	4 85	
	16	C. A. Waldron, expenses	6 50	
	17	Geo. H. German, expenses	2 00	
	45	C. W. Young, expenses	12 01	
				$137 87

Other Meetings.

	45	C. W. Young, expenses	$7 96	
	47	M. L. Dean, expenses	5 88	
	48	F. E. Skeels, expenses	28 40	
	82	E. W. Hardy, expenses	8 62	
	87	J. E. Rice, expenses	8 05	
	97	L. W. Barnes, expenses	3 70	
	93	M. P. Anderson, expenses	5 73	
Sept. 12	112	Eugene Fifield, expenses	6 50	
11	100	W. E. Boyden, expenses	5 46	
12	101	John Marshall, expenses	5 50	
11	101a	C. A. Waldron, expenses	7 30	
11	105	B. E. Hall, expenses	5 38	
	106	H. H. Hinds, expenses	10 36	
	108	H. R. Dewey, expenses	3 02	
	110	John McKay, expenses	1 45	
	115	Frank Maynard, expenses	11 70	
	195	C. W. Young, expenses	6 80	
	84	W. P. Custard, expenses	12 64	
				144 45

Business Committee.

Sept. 12	112	Eugene Fifield, expenses	$39 70	
	113	Eugene Fifield, expenses and salary	317 25	
Oct. 6	194	Eugene Fifield, expenses	27 90	
				384 85

Finance Committee.

Sept. 11	110	John McKay, expenses and salary	$55 80	
				55 80

Reception Committee.

Sept. 11	93	M. P. Anderson, expenses and salary	$27 03	
Oct. 6	185	I. H. Butterfield, secretary, hack bill paid	3 00	
				30 03
		Amount carried forward		$753 00

		Amount brought forward		$753 00

Legislative Committee.

July 8	45	C. W. Young, expenses	$14 19	
Aug. 22	54	F. E. Skeels, expenses	13 80	
Sept. 11	106	H. H. Hinds, expenses	13 93	
	108	H. R. Dewey, expenses	11 75	
12	112	Eugene Fifield, expenses	11 92	
				65 59

President's Office.

Sept. 12	116	M. B. Armstrong, assistant, services	$18 00	
Oct. 6	202	E. Howland, salary	100 00	
				118 00

Secretary's Office.

Mar. 26	24	The Richmond-Backus Co., Letter Press	$9 83	
31	25	I. H. Butterfield, sundries	5 40	
Apr. 1	27	Grand Rapids Insurance Agency, Sec'y Bond	7 50	
May 11	34	I. H. Butterfield, secretary, clerk	3 45	
June 23	37	I. H. Butterfield, secretary, expenses	18 70	
July 8	43	I. H. Butterfield, secretary, part salary	200 00	
	44	I. H. Butterfield, secretary, clerk hire	4 25	
Sept. 12	104	C. O. Cowles, clerk	26 28	
	111	P. M. Lyman, clerk	61 75	
	127	E. N. Ball, clerk	12 90	
Oct. 5	166	Miss Mary Holser, clerk	31 50	
6	185	I. H. Butterfield, secretary, clerk hire	45 00	
	186	I. H. Butterfield, secretary, pay roll, clerks	100 00	
	201	I. H. Butterfield, secretary, balance salary	800 00	
				1,326 56

Treasurer's Office.

Sept. 12	119	C. W. Young, pay roll clerks	$195 50	
	120	C. W. Young, salary	400 00	
Oct. 6	195	C. W. Young, expenses	24 91	
				620 41

Cattle Department.

Sept. 11	100	W. E. Boyden, expenses, salary judges	$103 28	
				103 28

Horse Department.

Sept. 11	80	C. A. Waldron, supt., paid judges and assistants	$20 00	
	101a	C. A. Waldron, supt., salary and expenses	53 29	
				73 29

Sheep Department

Sept. 11	78	D. P. Dewey, judge	$10 60	
	88	C. C. Dorr, judge	22 25	
	108	H. R. Dewey, supt., expenses and salary	52 42	
	180	R. S. Shaw, judge, expenses	12 00	
				97 27
		Amount carried forward		$3,157 40

			Amount brought forward		$3,157 40

Speed Department.

Mar.	30	23	H. G. Hess, time announcer	$50 00	
July	8	41	American Trotting Association Membership	50 00	
Sept.	8	72	Speed purses, paid Eugene Fifield, supt	1,000 00	
	9	73	Eugene Fifield, speed purses	1,500 00	
	10	77	Eugene Fifield, speed purses	1,500 00	
	11	99	Eugene Fifield, speed purses	1,000 00	
	12	107	Eugene Fifield, judges, care of track, etc	185 80	
		109	J. F. Rundell, assistant and expenses	45 31	
		121	Geo. S. Ward, clerk, speed	180 95	
		128	Samuel Kerr, judge	25 00	
	15	135	The American Sportsman—advertising	15 00	
		140	The Kentucky Stock Farm—advertising	10 00	
	18	148	The Home Review—advertising	16 05	
		151	The Western Horseman—advertising	15 00	
		152	The Chicago Horseman—advertising	13 75	
					5,606 86

Swine Department.

Sept.	10	75	L. W. Dehwart, judge	$30 00	
	11	97	L. W. Barnes, supt., expenses and salary	49 55	
					79 55

Poultry Department.

Oct.	5	193	C. A. Waldron, supt., paid judge	$25 00	
	12	205	Daniel Thomas, assistant superintendent, salary	30 00	
					55 00

Farm and Garden.

Sept.	11	82	E. W. Hardy, supt., expenses and salary	$61 56	
	11	114	M. L. Dean, judge	9 95	
					71 51

Dairy Department.

Sept.	12	101	John Marshall, supt., expenses and salary	$61 85	
	12	116	M. B. Armstrong, assistant	3 00	
					64 85

Farm Implement Department.

Sept.	15	133	John A. Hoffman, supt., expenses and salary	$109 18	
					109 18

Vehicle Department.

Sept.	15	87	J. E. Rice, supt., expenses and salary	$52 55	
					52 55

Main Building.

Sept.	11	79	F. L. Reed, assistant, expenses	$18 47	
Oct.	6	188	F. E. Skeels, supt., expenses and salary	45 00	
					63 47

Art Department.

Sept.	11	105	B. E. Hall, supt., expenses and salary	$90 33	
					90 33
			Amount carried forward		$9,350 70

		Amount brought forward		$9,350 70
		Needlework Department.		
Oct. 6	182	Mrs. F. E. Skeels, supt., expenses and salary	$51 43	
				51 43
		Horticultural Department.		
July 21	47	M. L. Dean, supt., expenses	$4 88	
Sept. 11	85	G. E. Rowe, judge	40 00	
	114	M. L. Dean, supt., expenses, salary, judge, etc	83 63	
12	122	Pontiac Cold Storage Company, storage	25 00	
	212	I. H. Butterfield, paid Anderson (plates)	6 50	
				160 01
		School Department.		
Sept. 12	115	Frank Maynard, supt., expenses and salary	$53 72	
				53 72
		Gate Department.		
Sept. 11	81	W. P. Custard, supt., pay roll gatemen	$284 02	
	84	W. P. Custard, supt., expenses	16 79	
	86	W. P. Custard, supt., salary	30 00	
				330 81
		Police Department.		
Sept. 11	95	E. N. Ball, supt., police pay roll	$591 85	
12	127	E. N. Ball, supt., expenses and salary	50 62	
12	129	E. N. Ball, supt., balance pay roll	26 00	
				668 47
		Marshal's Department.		
Sept. 11	106	H. H. Hinds, expenses and salary	$47 86	
Oct. 6	194	Eugene Fifield, use of horse	5 00	
				52 86
		Privileges and Concessions.		
Oct. 6	198	F. G. Jacobs, help, assistants salary, etc	$370 87	
				370 87
		Forage Department.		
Sept. 11	98	H. G. German, supt., expenses and salary	$38 50	
				38 50
		Postage.		
Mar. 31	25	I. H. Butterfield, secretary, stamps	$26 30	
May 11	32	I. H. Butterfield, secretary, stamps	50 00	
June 29	38	H. A. Wycoff, postmaster, stamps	100 00	
July 8	45	C. W. Young, treasurer, postage	8 35	
Sept. 12	111	P. M. Lyman, postage	70	
	115	Frank Maynard, postage	3 24	
Oct. 6	187	I. H. Butterfield, secretary, postage	103 80	
	188	F. E. Skeels, postage	4 72	
	194	Eugene Fifield, postage	10 00	
	195	C. W. Young, treasurer, postage	3 00	
1904.				
Jan. 11	213	I. H. Butterfield, secretary, stamps	27 00	
				337 11
		Amount carried forward		$11,414 48

Amount brought forward.. $11,414 48

Printing and Stationery.

1903.				
Mar. 5	21	Barnes Crosby Company, cuts..................	$10 00	
31	25	I. H. Butterfield, secretary, rubber stamps........	2 75	
April 14	29	The Berger Engraving Company, electros........	6 74	
3	28	Joseph Mack Printing House, blank vouchers......	13 50	
April 18	30	E. M. Weatherhead, letter heads.................	50 75	
May 11	34	I. H. Butterfield, secretary, cuts................	6 84	
20	35	Oak County Democrat, speed cards and stickers....	9 00	
June 5	37	Commercial Printing Company, envelopes.........	13 75	
23	39	I. H. Butterfield, secretary, sundries..............	2 43	
July 3	40	Robert Smith Printing Company, envelopes and circulars....................................	26 85	
8	45	C. W. Young, envelopes and printing..............	5 15	
Sept. 15	62	Union Print Company, envelopes and labels.......	6 70	
	68	The Detroit Free Press, button tags..............	8 75	
	139	Fair Ticket and Supply Company, entry books.....	21 85	
22	159	Pontiac Publishing Company, sundry printing.....	86 40	
23	161	Pontiac Gazette, sundry printing................	118 10	
Oct. 5	176	C. & J. Gregory, tickets.........................	24 50	
	179	Commercial Print Company, envelopes, letter heads, etc....................................	15 75	
6	185	I. H. Butterfield, secretary, circulars and stamps..	2 20	
	189	I. H. Butterfield, secretary, tubes, electros, etc....	9 52	
	190	I. H. Butterfield, secretary, stamps..............	75	
Nov. 4	207	Fair Ticket and Supply Company, tickets........	30 00	
1904.				
Jan. 11	212	I. H. Butterfield, secretary, sundry bills paid.....	12 93	
				485 21

Advertising.

Mar. 5	21	Barnes Crosby Company, half tones and electros..	$139 45	
31	25	I. H. Butterfield, secretary, paid sketch..........	6 15	
30	26	F. B. Howlett, solicit advertising................	68 44	
April 3	28	Joseph Mack Print Company, electros for blotters..	4 75	
14	29	The Berger Engraving Company, cuts...........	3 85	
18	30	E. M. Weatherhead, prospectus and cards........	8 75	
May 11	33	Barnes Crosby Co., half tones..................	79 37	
June 5	37	Commercial Print Company, blotters............	136 50	
23	39	I. H. Butterfield, secretary, paid, advertising.....	3 50	
July 3	40	Robert Smith Printing Company, cloth posters...	33 00	
8	42	S. S. Crohn, advertising in pamphlet.............	10 00	
	44	I. H. Butterfield, secretary, paid solicit advertising.	10 00	
	45	C. W. Young, solicit advertising.................	2 05	
25	49	Robert Smith Printing Company, premium lists...	3,550 00	
20	52	The Berger Engraving Company, cuts and electros	16 18	
29	53	C. D. Cowles, distributing premium lists.........	20 00	
July 29	55	Johnson, Randall Company, fans................	40 80	
Aug. 29	56	Morrison Printing Company, cloth banners.......	60 00	
Sept. 10	58	The Redman Distributing Company, distributing advertisements...........................	35 84	
	59	The O. L. Elston Company distributing advertisements................................	14 00	
12	60	J. H. Sanders Publishing Company, advertising...	19 60	
15	61	Cal. M. Gillette, distributing advertisements......	11 65	
15	62	Union Printing Company, advertising...........	4 80	
15	63	F. D. Eddy & Company, distributing advertisements...................................	11 62	
	64	Wm. Walter, distributing advertisements........	13 00	
	65	Lyons & Company, distributing advertisements...	12 00	
	66	The Gleaner, advertising......................	33 40	
12	67	Joseph Mack Printing Company, hangers.........	80 00	

Amount carried forward.. $11,899 69

		Amount brought forward		$11,899 69
15	68	The Detroit Free Press, car banners	4 75	
	69	H. M. Underwood, distributing advertisements	19 55	
12	70	Barnes Crosby Company, cover, cut, and half tones	90 36	
10	76	H. C. Devlin, distributing advertisements	2 00	
13	83	The Milford Petry Company, elect. car advertising	115 00	
11	87	J. E. Rice, distributing advertisements	2 15	
	93	M. P. Anderson, distributing advertisements	3 32	
	100	W. E. Boyden, distributing advertisements	1 33	
12	101	John Marshall, distributing advertisements	3 00	
15	102	Edgar Noble, distributing advertisements	27 10	
12	104	C. D. Cowles, distributing advertisements	2 00	
11	110	John McKay, distributing advertisements	5 55	
12	111	P. M. Lyman, distributing advertisements	13 10	
	112	Eugene Fifield, distributing advertisements	15 46	
	121	G. S. Ward, distributing advertisements	2 00	
	127	E. N. Ball, distributing advertisements	6 00	
	131	I. H. Butterfield, paid distributing advertisements	26 00	
15	138	Peninsular Engraving Company, electros	7 15	
17	142	Evening News Association	219 12	
18	145	S. S. Cornell, distributing advertisements	9 25	
	146	Flint Daily Journal, advertising	16 80	
	147	The Michigan Sugar Beet, advertising	8 00	
	149	Detroit Journal, advertising	150 00	
	150	Commings & Balch, advertising	8 00	
	153	Daily Abend Post, advertising	24 00	
	154	The Detroit Free Press, advertising	132 00	
	155	Patterson Bros., Holly, advertising	10 00	
	157	Lapeer Co. Press, advertising	10 00	
	158	The Angelus, advertising	25 00	
22	159	Pontiac Publishing Company, printing and advertising	197 20	
23	161	Pontiac Gazette, printing and advertising	48 58	
27	164	The Geo. M. Savage Agency, advertisements in 153 papers	250 00	
29	165	Robert Smith Printing Company, printing and ft. on premium lists	279 57	
Oct. 5	169	Courier Herald Company, Saginaw, advertising	8 40	
	174	The Detroit To-Day Company, advertising	48 00	
1	177	Detroit Legal News Company, advertising	9 00	
5	181	Holly Herald, advertising	13 75	
6	182	Mrs. F. E. Skeels, distributing and advertising	9 52	
	185	I. H. Butterfield, secretary, paid D. Lane	2 70	
	188	F. E. Skeels, distributing advertisements	3 50	
	190	I. H. Butterfield, secretary, paid bills	8 15	
12	204	Saginaw Evening News, advertising	16 80	
8	206	Michigan Farmer, advertising	90 72	
	210	Brett & Arnold paper and advertising	10 00	
1904.				
Jan. 11	214	I. H. Butterfield, secretary, bills paid	85 90	
	215	I. H. Butterfield, secretary, bills paid	74 27	
		I. H. Butterfield, secretary, bills paid	9 05	
				6,551 80
		Amount carried forward		$18,451 49

			Amount brought forward		$18,451 49

General Expenses.

Mar.	5	22	Eugene Fifield, photographs	$70 49	
July	23	48	B. E. Hall, expenses Maccabee	76 00	
Sept.	12	123	S. S. Crohn, entertainment bureau	64 00	
		124	F. J. Stuart & Co., straw	289 16	
		130	C. D. Butterfield, assistant phot. and attrac	25 00	
	23	162	Michigan Fish Commission Exhibit	351 22	
	24	163	Waite Bros. & Robertson, sundry material	123 69	
Oct.	5	175	E. Michigan Asylum, rent of barn	5 75	
		209	E. Howland, rent of office	25 00	
Jan.	11	217	I. H. Butterfield, secretary, paid J. S. Stone	20 00	
					1,050 31

Buildings and Grounds.

Jan.	31	18	Oakland County Agricultural Society, material	$132 66	
Feb.	2	19	Howard Smith, balance bill painting	19 43	
Mar.	5	20	Oakland County Agricultural Society, rent	1,000 00	
July	8	46	Chas. Durkee, Jr., team work	17 50	
Aug.	22	54	F. E. Skeels, pay roll, labor	34 23	
Sept.	10	57	Detroit United Railway, cinders	10 36	
	12	71	Detroit Mill lumber	310 34	
	10	74	F. E. Skeels, pay roll, labor	513 62	
	12	107	Eugene Fifield, lumber	25 00	
		117	E. Howland, ft. paid on stone	30 00	
		125	F. E. Skeels, pay roll, labor	523 06	
		131	I. H. Butterfield, secretary, paid labor	6 63	
	15	132	J. McLaren, painting roof	77 21	
		134	C. S. Bartlett, work on grounds	12 40	
		136	Detroit Bag & Manufacturing Co., decorating tents, signs, etc	430 90	
		137	Howland Manufacturing Company, stakes	12 00	
		156	Onyx Paint Company, paint and oil	13 25	
Oct.	5	170	E. J. Hallett, pipe and material	256 81	
	6	171	A. A. Corwin, lumber	42 90	
	5	172	Millis Bros., lumber	141 28	
		175	E. Michigan Asylum cinders	20 60	
		178	Pontiac Ice & Fuel Company, tile	64 81	
	6	184	F. E. Skeels, pay roll, labor	500 74	
		191	I. H. Butterfield, secretary, ft. paid lumber	19 00	
		192	I. H. Butterfield, secretary, laundry cloth	6 00	
		196	E. Howland, cinders, stone, paint	113 42	
		203	F. J. Poole, lumber	24 65	
		197	F. G. Jacobs, booths	818 76	
		199	F. G. Jacobs, paid labor bills	453 20	
Nov.	16	208	Oakland County Agricultural Society, rent	143 00	
		185	F. E. Skeels, supt., services and express	123 50	
Jan.	11	217	I. H. Butterfield, secretary, paid Durkee labor	11 00	
					5,908 26

Telegraph and Telephone.

June	23	39	I. H. Butterfield	$0 55	
Aug.	22	54	F. E. Skeels	1 50	
Oct.	5	167	W. U. Telegraph Company, bill	4 78	
	6	183	Michigan Telephone Company rent and service	17 71	
		195	C. W. Young bill	1 00	
Jan.	11	216	I. H. Butterfield, secretary, bill paid	1 70	
					26 24
			Amount carried forward		$25,436 30

		Amount brought forward		$25,436 30

Freight and Express.

Mar. 31	25	I. H. Butterfield, secretary, bills paid	$6 10	
April 18	31	American Express Company, bill	6 00	
May 29	36	American Express Company, bill	7 40	
June 23	39	I. H. Butterfield, secretary, bills paid	4 64	
July 28	50	American Express Company, bills paid	10 76	
	51	American Express Company, bills paid	15 55	
Sept. 16	143	American Express Company, bills paid	40 58	
Oct. 6	195	C. W. Young, ft. paid	1 00	
Jan. 11	216	I. H. Butterfield, secretary, bills paid	26 44	
				118 47

Diplomas, Ribbons, Badges.

Mar. 31	25	I. H. Butterfield, paid filling diplomas	$3 00	
Sept. 24	163	Waite Bros. & Robertson, ribbons and buttons	40 20	
Oct. 5	173	Armstrong Regalia Company, prize ribbon and badges	107 20	
	173	Armstrong Regalia Company, two badges	1 30	
				151 70

Attractions.

Sept. 10	76	H. C. Devlin, military drill	$200 00	
11	89	A. M. Schreyer, chute	625 00	
	90	The Rexos Roller Skates	125 00	
	91	Edw. Musliner, sheep and pigs	175 00	
	92	Mrs. Frances Dack, spinning wheel	50 00	
	103	B. E. Hall, Maccabee prize	243 00	
12	118	G. H. Turk, fire teams	195 80	
Oct. 6	191	I. H. Butterfield, ft. fire teams paid	54 00	
				1,667 80

Music.

Sept. 11	96	Oakland Light Infantry Band, band music	$122 00	
12	119a	K. O. T. M. Band, band music	200 00	
				322 00

Sundry Expenses.

Mar. 31	25	I. H. Butterfield, secretary, expenses paid	$9 75	
May 11	34	I. H. Butterfield, paid Seeley premium 1902	4 00	
July 8	44	I. H. Butterfield, bill file 1902	4 94	
Sept. 11	78	D. P. Dewey, judge election	2 00	
	94	C. E. Walter, photographs	51 74	
	105	B. E. Hall, expenses	3 33	
	126	Bay City Hardware Company, ticket boxes	19 50	
15	141	Union Buggy Company, harness for prize	17 00	
18	144	Arnold & Fregard, robes and whip for prize	37 00	
1902-03.				
22	160	A. C. Adams & Company, furniture for president's office	22 20	
Oct. 5	168	C. E. Walter, printing photographs	38 10	
6	189	I. H. Butterfield, secretary, paid L. Newton premium 1902	10 00	
	192	I. H. Butterfield, secretary, sundry	5 50	
	200	Geo. Bird, damage to fence	5 00	
1904.				
Jan. 11	212	I. H. Butterfield, secretary, bills paid	4 25	
	216	I. H. Butterfield, secretary, bills paid	13 52	
				247 83
				$27,944 10

SUMMARY.

Winter meeting	$137 87
Other meetings	144 45
Business Committee	384 85
Finance Committee	55 80
Reception Committee	30 03
Legislative Committee	65 59
President's Office	118 00
Secretary's Office	1,326 56
Treasurer's Office	620 41
Cattle Department	103 28
Horse Department	73 29
Sheep Department	97 27
Speed Department	5,606 86
Swine Department	79 55
Poultry Department	55 00
Farm and Garden Department	71 51
Dairy Department	64 85
Farm Implement Department	109 18
Vehicle Department	52 55
Manufactures, main building	63 47
Art Department	90 33
Needlework Department	51 43
Horticulture Department	160 01
School Department	53 72
Gate Department	330 81
Police Department	668 47
Marshal's Department	52 86
Privileges and concessions	370 87
Forage Department	38 50
Postage	337 11
Printing and stationery	485 21
Advertising	6,551 80
General expenses	1,050 31
Buildings and grounds	5,908 26
Telephone and telegraph	26 24
Freight and express	118 47
Diplomas, ribbons and badges	151 70
Attractions	1,667 80
Music	322 00
Sundry expenses	247 83
Total	$27,944 10

REPORT OF THE TREASURER.

To the President and Members of the Executive Committee of the Michigan State Agricultural Society:

Gentlemen—I have the honor to submit the following as my report for the year 1903.

Jan. 28, 1903	Cash on hand		$13,601 80
	Receipts during year—		
	General admissions	18,458 75	
	Railroad coupons	9,434 75	
	Grandstand	3,485 75	
	Privileges	4,150 51	
	From secretary	3,676 10	
	Speed	3,225 36	
	State appropriation	5,000 00	
	Memberships sold by treasurer	140 00	47,571 22
	Total		$61,173 02
	Disbursements—		
	Business orders paid	$27,982 06	
	Premium vouchers paid	13,776 83	41,758 89
Jan. 13, 1904	Cash on hand		$19,414 13

Respectfully submitted,
Signed, C. W. YOUNG,
Treasurer.

Pontiac, January 13, 1904.

Endorsement of the Finance Committee.

We have examined the above account and approve the same.

Signed, JOHN McKAY,
H. R. DEWEY,
G. H. GERMAN,
Finance Committee.

CLASSIFICATION OF ENTRIES WITH AMOUNT AWARDED.

	Entries.		Premiums awarded.
Cattle	835		3,893 00
Horses	258		1,158 00
Sheep	1,120		2,632 00
Swine	673		1,563 00
Poultry	1,464		926 00
Farm and garden products	385		460 00
Dairy products	149		398 75
Materials	23	14 Diplomas and	8 00
Art	445		794 00
Needlework	692		339 25
Fruit, canned goods and flowers	1,091		1,376 00
School work	254		272 00
Totals	7,398		$13,818 00

REPORT OF EXECUTIVE SUPERINTENDENTS.

CATTLE.

Mr. President and Members of the Executive Committee of the Michigan State Fair:

Gentlemen—As Superintendent of Cattle Department I submit the following report: The exhibit as a whole was a very creditable one. In several instances the Michigan exhibits compared well with exhibits from out of the State. Although somewhat crowded for room, all seemed willing to crowd up all they could and through the prompt action of our Business Committee in putting up the large tent, and the courtesy of Steward Smith of the Eastern Michigan Asylum, we finally got quite comfortably settled.

At present I believe there are no Devon cattle bred in Michigan and the foreign exhibit seems to be deteriorating; I would therefore suggest that this class be dropped from our list and a class for Polled Durham be substituted.

All of which is respectfully submitted.

W. E. BOYDEN,
Superintendent of Cattle.

The report was accepted and referred to the Premium Committee.

HORSES.

To the President and Executive Committee of the Michigan State Agricultural Society:

Gentlemen—As Superintendent of Division B., Horses, I would submit the following report. The total number of entries were 258, divided as follows:

Standard bred	43	Hackney, open	9
Roadsters	16	Hackney, Michigan	9
Carriage	23	Percheron, open	10
Saddle	5	Percheron, Michigan	13
All work	62	Clyde or Shire, open	5
Cleveland Bay	0	Clyde or Shire, Michigan	7
French Coach, open	2	Grade draft	43
French Coach, Michigan	3	Shetland	8

The quality was good but the numbers in the coach and draft classes were small.

C. A. WALDRON,
Superintendent of Horses.

On motion, the report was accepted and referred to committee.

SPEED.

To the President and Members of the Executive Committee of the Michigan State Agricultural Society:

Gentlemen—As Superintendent of the Speed Department, I desire to submit you the following report:

Our free-for-all class for trotting horses did not fill and we did not have to pay the purse.

Receipts and disbursements for this department were as follows:

Received for entrance money	$2,550 00
Received for score card privilege	116 36
Received for pools	409 00
Received receipts from grand stand	3,485 75
	$6,561 11

Attractions, including fire teams and Maccabees	$1,632 80
Disbursements in ten classes	4,800 00
Paid Steiner dues for 1903	50 00
Paid Snider, starting judge	75 00
Geo. Ward, secretary and advertising	162 95
Kerr Drovis	25 00
	$6,745 75

We had a very successful meeting. Our races filled, with the exception of the free-for-all trot, which we did not expect to fill when we offered the purse, but did it so that no horseman could say that he did not have a place to race a fast horse.

Our starting judge did remarkably well, and our judges of the races did all they could to show they meant to deal fairly with the horsemen as well as the public.

Mr. Nealy, driver of Nellin Online, was fined $10 for laying up the third heat in the 2:14 pace. Mr. VanAuken, driver of Minaloyd, was fined $10 for laying up the first and second heat in the 2:14 pace. Driver of Glen H. was fined $15 for laying up the first heat in the 2:25 trot. After he was fined he immediately went on and won the race.

We believe we have reasons to congratulate ourselves on the large success of our meeting, and I think the success was due largely to the amount of purses we offered, as several meetings were declared off and not a success in other towns.

I would recommend that we offer for our races the coming fall not less than $500 per race.

Respectfully yours,
EUGENE FIFIELD,
Superintendent of Speed.

On motion, report was received and referred to proper committee.

SHEEP.

To the President and Executive Committee of the Michigan State Agricultural Society:

Gentlemen—The exhibit of sheep for 1903 in all the different breeds was of a high quality and would have done credit to any state. The general result of the exhibit was a great success, both for the breeders and the Society, and I can see no reason why those who desire fine sheep for breeding or other purposes should go outside of Michigan for them.

The entries were 1,120. Amount offered in premiums, $3,166. Amount awarded, $2,632. As to full detail I refer you to the report of the Secretary.

The judges in this department were men of high character and attainments, doing their work with due consideration, without fear or favor.

H. R. DEWEY,
Superintendent.

SWINE.

To the President and Executive Committee of the Michigan State Agricultural Society:

Gentlemen—The exhibit of swine at our fair in 1903 was a record-breaker in point of numbers and good in quality.

The total number of entries in all classes were 673, as against 591 in 1902, and 638 in 1901.

Several fine herds came after our pens were crowded to the extreme and were returned home at no little expense and disappointmnt to their owners.

We did the best we could under the circumstances, but it seems evident that we must have more pens provided for swine, and should have a more convenient and suitable place to show. Exhibitors were very considerate and good feelings prevailed.

Respectfully submitted,
L. W. BARNES.
Superintendent of Swine.

Moved the report be received and referred to committee.

POULTRY.

To the President and Officers of the Michigan State Agricultural Society:

Gentlemen—In making my report of the Poultry Department of the fair in 1903, I would state that the exhibit of poultry, etc., was very fine and above the average, considering the large exhibit. There was no sickness among the stock, as there was in 1902.

A large number of poultry breeders sent their stock but were unable to stay themselves longer than one day and I had their stock returned to them before I left the grounds the last day of the fair and all without a loss or a single complaint from any person, and I might say that the reason that many fanciers and breeders showed their stock this year was that they were promised ribbons in the place of cards.

I have inclosed a list of various breeds, also the number in each class. I would recommend that the poultry house be enlarged and a better ribbon be procured. All of which I respectfully submit for your consideration.

DANIEL THOMAS,
Superintendent of Poultry.

The report was accepted and referred to committee.

FARM AND GARDEN PRODUCTS.

To the President and Executive Committee of the Michigan State Agricultural Society:

Gentlemen—The exhibit in Division F. was fully up to former years. The total number of entries for 1903 was 385. and the entries for the year 1902 was 307. Total premiums paid last fall, $460.

I would recommend a general revision of at least a portion of our premium list for this Department.

Respectfully submitted,
E. W. HARDY,
Superintendent.

Accepted and referred to proper committee.

DAIRY, BEES AND HONEY.

To the President and Members of the Executive Committee of the Michigan State Agricultural Society:

Gentlemen—As Superintendent of Division G., Class 52, 53 and 54, I herewith beg to report as follows:

Entries in creamery butter,	12, amount awarded......	$89 95
Entries in dairy and point butter,	38, amount awarded......	64 92
Entries in cheese,	38, amount awarded......	144 88
Entries in bread, cakes, etc.,	56, amount awarded......	47 00
Entries in bees and honey,	9, amount awarded......	52 00
Total	153	$398 75

The entries in all classes were above the average in quality.

There was also a large display of dairy utensils and implements, particularly in cream separators.

Respectfully submitted,
JOHN MARSHALL,
Superintendent.

On motion, the report was accepted and referred to proper committee.

VEHICLES.

Mr. President and Members of the Executive Committee of the Michigan State Fair:

Gentlemen—In the Carriage and Vehicle Department I would most respectfully report the greatest exhibit ever offered in the State.

The number of exhibitors in 1903 were 25. Total number of carriages, heavy and light, were 376. Total value as carefully computed, $31,473.50.

All of which is most respectfully submitted.

J. E. RICE,
Superintendent.

On motion, the above report was accepted.

AGRICULTURAL IMPLEMENTS AND MACHINERY.

Mr. President and Members of the Executive Committee of the State Agricultural Society:

Gentlemen—The Superintendent of the Farm Implement and Machinery Department begs leave to report a most excellent exhibit in his department. The number of exhibitors were 106 in all, covering the territory from the New England States to the Missouri river, and I think it was the best display of traction engines, corn huskers and shredders ever made at a State Fair in Michigan.

Attached to this report you will find a detailed one giving the name and address and the article exhibited. The accommodations extended to the Power Department by means of the water mains was very much appreciated, also the very fine road built from the railroad docks in on the grounds and the improved condition of the real road docks. I do not now recall any just complaints against the accommodations or management of the fair. I thank each and every one of you for the many favors extended to me in my official position.

Most respectfully submitted,
JOHN A. HOFFMAN,
Superintendent.

Upon motion, the report was accepted.

MAIN BUILDING.

Officers and Members of the Executive Committee of the Michigan State Agricultural Society:

As Superintendent of the Howland Building which includes manufactured and some miscellaneous articles, I desire to report. The several departments in this building will of course be represented by the several superintendents having them in charge and I wish only to add that as a combined exhibition this main building presented the best I have ever seen at our fair.

The fruit and dairy interests alone would have filled the entire first floor of the hall if the room could have been spared to them.

The fish exhibit was very fine and as usual attracted more people than

any other exhibit in the building. The exhibitions of the educational institutions of the State were of the best and should be encouraged.

Very few of the exhibits in my charge are entered for the purpose of obtaining premiums or diplomas. There were 23 entries. The Department offers $42 and of this amount $8 was awarded, with a number of diplomas.

Respectfully submitted,
F. E. SKEELS,
Superintendent.

On motion, the above report was accepted.

ART DEPARTMENT.

To the Officers and Members of the Executive Committee of the Michigan State Agricultural Society:

Gentlemen—As Superintendent of Art at the State Fair, held at Pontiac, Michigan, September 7, 1903, I submit the following report:

Total premiums offered all classes, $891.50. Awarded, $797.

We had a very fine complimentary exhibit from the Art Museum of Detroit, work of some of the best artists in the State, which added largely to the display and with very little expense. For this we feel under obligations to Prof. A. H. Griffith, superintendent.

I was informed by artists and exhibitors who have attended the State fairs, that we had the largest, also the best exhibit this year in this Department ever made in this State.

Recommendations.—I would recommend that premium lists be printed on separate sheets so they can be placed in the hands of the artists a little earlier to give them more time to prepare new work for this department.

That skylights be put in and the side windows boarded up, this would give better light and would show up the work to a better advantage, and it would also give more room to display oil paintings.

That different color than red cloth be put on the walls as the red destroys the effect of the paintings.

Respectfully submitted,
BYRON E. HALL,
Superintendent.

On motion, the above report was received and referred to proper committee.

NEEDLE WORK AND CHILDREN'S WORK.

Officers and Members of the Executive Committee of the Michigan State Agricultural Society:

Gentlemen—As Superintendent of Needlework, I desire to report:

The exhibit was the finest ever made during my experience with your Society.

With a desire to draw out a finer display from professionals and art dealers your committee, at my suggestion, kindly changed the professional list, grouping the exhibit under one head and offering one large premium of $175. The result was very disappointing as the large firms

in Detroit, Grand Rapids, and Saginaw, which promised to make fine displays, did not compete at all.

The entries show an increase of 12 per cent over the entries of 1902.

I would respectfully recommend a revision of the needlework department in the premium list, with very little, if any, change in the total amount offered and with this in view have prepared a new list which I present for the consideration of your committee.

This will make a list for professional workers similar to the one prepared for the amateur exhibitors, with offerings somewhat higher than those in the amateur list.

Sincerely,
MRS. F. E. SKEELS,
Superintendent of Needlework.

On motion, the report was accepted and referred to committee.

SCHOOL EXHIBITS.

To the President and Executive Committee of the Michigan State Agricultural Society:

Gentlemen—As Superintendent of Division S., (School Exhibit) I beg leave to submit the following report:

The school exhibit at the fair of 1903 was the finest we have ever had in this department, success in this department at future fairs seems assured. The broad field open here for competition, which is inviting the attention of some of our best educators and brightest students, would seem to require that more money be offered in premiums.

I would, therefore, recommend that the total amount offered in the school department be increased to $500.

Respectfully submitted,
FRANK MAYNARD,
Superintendent.

HORTICULTURE.

To the President and Members of the Executive Board of the Michigan State Agricultural Society:

Dear Sirs—Not being able to meet with you. I hereby submit my report as Superintendent of the Horticultural Division for 1903.

It is needless to say that space was inadequate, but the exhibitors were patient and by the addition of a tent and tables all were comfortably taken care of although the entire display was too crowded for best results from an exhibition standpoint.

The time has come when it seems almost necessary that this association should have some permanent location where buildings suitable for different divisions could be erected, however, it may not be advisable to make the outlay this year during the St. Louis Exposition, because it has been the history of expositions in the past that they have detached from the best results of our fairs.

The totals of fruits and plants displayed are as follows. Single plates:

Apples	1,667
Crab	109
Pear	584
Peach	483
Plum	585
Grape	192
Quince	11
Blackberry	1
Cherry	3
Strawberry	3
Red Raspberry	1
English Walnut	1
Elderberry	1
Cranberry	2
Chestnut	1
Japan Walnut	1
Pecan	2
Total	3,647

Cans of fruit	132
Cans of vegetables	22
Cans of pickles	79
Cans of jellies	76
Cans of dried fruit	16
Cans of wines	24
Total	349

Cut flowers, 96 vases; plants in pots, 485; floral pieces, 4.

I suggest the following: First, that competition in general and special collections should be restricted to Michigan fruit growers, but on single plates allow outside entries from any state.

Second. That all collections should include 50 or more plates where not otherwise specified.

Third. That Menominee county be added to the list of lot 1,489. class 66.

Fourth. Having restricted collections to Michigan fruit growers, I believe that we should offer a premium of $35 first and $15 second for best collections of fruit from any society or individual from any other state.

Respectfully submitted,

M. L. DEAN,
Superintendent.

On motion, the above report was received and referred to proper committee.

GATES.

To the President and Executive Committee of the Michigan State Agricultural Society:

Gentlemen—Being Superintendent of Gates, I make the following report:

I employed 15 men to take tickets, that included grand stand men. Paid gatemen $3 per day and railroad fare, excursion rates. Paid grand stand men $1.50 for each one-half day they worked; making a total of $264.31.

All of which I respectfully submit.

W. P. CUSTARD,
Superintendent of Gates.

SUPERINTENDENT OF POLICE.

Officers and Members of the Michigan State Agricultural Society:

Gentlemen—This being my first experience in the Police Department, the report, from my point of view, may not be entirely in accord with the opinions of others. My endeavor was to be successful, and if in any points I may have failed, it was due to lack of experience.

Harmony with all departments of the city and county in which police regulations are concerned was and is maintained.

Good order was maintained throughout the exhibition, and in the main, I believe good work was done, still I am aware that exceptions are probable, but as yet, knowing of criticisms. I am in the dark as to inefficiencies and where they may have occurred.

As you all know, large crowds were handled, requiring at times a large force, and I wish here to express my appreciation of the good will shown by the mayor of Pontiac, and the sheriff of the county, and of their prompt and valuable assistance in supplying help when needed.

The total number of men employed whose names are on the pay roll for long or short periods, is 67, and the expense of the department was $668.47.

No arrests were made, no fines were collected, but Tuesday morning doubtful games and propositions were invited to leave the grounds and circumstances brought to bear were such as caused them to depart.

Respectfully submitted,

E. N. BALL,
Superintendent of Police.

CONCESSIONS AND PRIVILEGES.

The expenses of this department were $370.87 as per voucher rendered. The receipts, $4,150.51—. Net receipts, $3,778.64+.

Mr. Robert Oakman, representing the Detroit United Railway, presented an invitation for the committee and citizens of Pontiac to a banquet at the Russel House, Friday evening, January 15th. The president announced that the invitation would be accepted with the thanks of the committee. Mr. Burdick, representing the Detroit United Railway, appeared before the committee in the interest of Pontiac as a permanent location for the fair. He announced that the equipment and power of the railway had been greatly improved during the last year and that in case the fair was located in Pontiac the service would be greatly improved over that of the years during which the fair had been held here.

Mr. Gragie, traveling passenger agent over the Grand Trunk also appeared as follows:

"Any reasonable improvements that you suggest that is an improvement on our last year's service we are perfectly willing to make. We thought we handled the trains very well last year. If the fair becomes permanent in Pontiac our people would be willing to go in and spend money so we could load and unload them in better shape."

Mayor Gillet of Pontiac presented the advantages of Pontiac as a place for the permanent location of the fair. He said the improvements already made and contemplated by the Detroit United Railway would add very materially to the number of people that could be brought to

the fair on the electric line. He also mentioned the fact that Pontiac was the center of a radius of 25 miles, which contained more people than any other section of the same size in the State.

The Superintendent of Transportation reported that the matter of transportation had been mostly left in the hands of the Secretary.

Mr. George C. Hupp, an exhibitor of swine, presented a claim for remuneration on account of loss claimed to have been suffered by reason of not being provided with pens in which to exhibit his stock. On motion, the claim of Mr. Hupp was referred to a committee of three, Messrs. Butterfield, Anderson, and Boyden.

Mr. Fifield offered the following resolution:

"Whereas, Hon. H. S. Earle, State Highway Commissioner, contributed of his time and energy without pay in the construction of a section of stone road and the exhibition of improved road machinery at the last State Fair, making an attractive and interesting exhibit;

Therefore resolved, That the Executive Committee tenders its thanks to Mr. Earle for his labors in connection with this exhibit and for his great interest in the improvement of public roads in the State, and we hereby pledge him our hearty support in prosecuting the movement for good roads."

The above resolution was unanimously adopted.

On motion of Mr. Hardy, Mr. R. C. Reed, Secretary of Livingston County Association of Breeders of Improved Live Stock, appeared before the committee and presented the following:

To the Honorable Board of Directors of the Michigan State Agricultural Society:

Gentlemen—Whereas, the shipping facilities for exhibtors on the present State Fair grounds at Pontiac are wholly inadequate to the requirements of the public, causing great delay and loss,

Therefore, we petition your honorable body to see to it that the present dockage and other facilities for shipping out stock from the fair grounds be increased at least two fold.

And whereas, The present method of conducting the Forage Department leads to exorbitant charges and dissatisfaction to exhibitors,

Therefore, we most earnestly petition your honorable body to take such action as shall secure to exhibitors hay and grain at a fair market price and that your guarantee concerning this matter shall be fulfilled.

And your petitioners will ever pray.

R. C. REED,
Secretary.

Unanimously adopted.

The communication was accepted and referred to the Business Committee.

Mr. A. E. Stevens, representing the Michigan Short Horn Cattle Breeders' Association, appeared and presented the request of that association, that the Michigan breeders be allowed to exhibit the same animal in both the Michigan class and class open to all. Mr. Stevens claims it is an injustice to Michigan breeders not to allow them to compete against those from outside the State and that other states that offer state premiums allow their state exhibitors to compete in both classes. He also re-

quested that a section be made for junior and senior in the yearling class.

Mr. Stevens also stated that the association had arranged for a sale to take place on the fair grounds in May and also desired to hold a sale on the fair grounds during the fair, providing the Society would furnish suitable accommodations for the same.

Mr. Stevens requests were received and that relating to the premium list was referred to the Premium Committee and that relating to sales to the Business Committee.

President Howland presented his address as follows:

To the Executive Committee, Michigan State Agricultural Society:

Gentlemen—It has been customary for the presiding officers of this Society to bring to the attention of the Executive Committee such matters as seemed, in their judgment, to demand adjustment. Following the precedent of my predecessors I will endeavor to point out some of the undesirable conditions that confront us at the present time and recommend, or at least suggest, such action as will, in my judgment, either remedy or alleviate the unfavorable conditions I shall refer to.

The Michigan State Agricultural Society is supposed to be a ward of the State, operating along agricultural and mechanical educational lines. Its methods are by object lessons, requiring lands, offices, buildings, railways and other facilities for accommodating quantities of goods and large assemblages of people.

We find the condition of this Society, after a series of exhibitions reaching back over a period of fifty years, such as to compel us to either rent, borrow or beg the accommodation we are in need of, and are forced to secure, before we can appropriately proceed with a single arrangement for a future exhibition and this is the third time in a period of three years that this condition has been in evidence. During the short time referred to there has been expended by the Society nearly $10,000, entirely of a temporary nature.

I assume, gentlemen, this condition to be undesirable because it is an impediment to desirable conditions. It confronts us when we petition state aid; it is in evidence when we negotiate with transportation companies; it deprives us of comfortable accommodations, without which we cannot attract the patronge of those seeking amusement, because comfort and amusement are close companions.

Other reasons exist, gentlemen, but I deem those already noted of sufficient importance to call for your immediate consideration of such measures as are likely to result in the acquiring of accommodations of a permanent nature. And next, after your attention has been given to the general arrangements that past experience has proved to be necessary and practical, I call your attention to the matter of state aid. In looking over the past history of this Society I conclude that for at least forty years of the immediate past the conditions have neither been beneficial to this Society or a credit to the State.

In proof of this assertion I offer some dates and figures obtained from the Secretary and which I presume to be entirely correct. These figures relate to appropriations by the State in the year 1849, from which year the charter is dated. Four hundred dollars per year was granted for five years. Beginning in 1851, two years later, finding the struggle too

great for the Society, the State helped it out with the additional sum of $600 for the balance of the five years. In 1856-57 this was continued. From 1857 to 1858, $2,000 per year; 1859 and 1860, $2,500 per year and from 1860 we note the astonishing leap over a period of 40 years, coming down to the banner year of prosperity, 1901, when the State of Michigan in consequence of its wonderful development, standing out in prominence as one of the component parts of the most prosperous nations on earth, by its Legislature doles out to this Society, to this home interest, to hold as trustee and to be disbursed to individual citizens of the State under certified conditions during a period of two years, the sum of $9,000. As I understand the situation this comprises the aid and assistance up to the present time the Society has received and in order to emphasize the propriety of taking action on this matter, I desire to use still more figures and lap back on to the forty-year period heretofore alluded to.

In the year 1893, a year of universal depression in business, especially in agricultural lines, wheat at that time the staple product of the State, selling at fifty cents a bushel—in this year the Legislature donated to an outside institution $100,000 of our money and on which our Society had more just and natural claims. And this during a period of forty years of total neglect of this home Society. This was repeated in 1901 to the amount of $43,000; again in 1903, to the amount of $50,000 to outside institutions organized to promote the same identical object as our home Society and while they last damaging to a degree nearly fatal to our Society. But notwithstanding the small amount of aid, being less than $25,000, it has held more than fifty exhibitions, paid large sums in premiums and benefited localities where the exhibitions have been held. The large sums, aggregating $193,000, and the institutions it has assisted to promote, have vanished in a single year, and all evidences of value received go to the wrecking company and the junk pile.

In reviewing past and present conditions I conclude that from the date of the organization of the Society to the year 1860 the State gave the Society all the assistance, with its comparatively limited resources, it could have been expected to. Its neglect during the Civil War and a period immediately following, is easily accounted for, but why it suffered neglect for a period of forty years I am unable to explain.

I believe our committeemen, representing so many localities of the State, by a determined effort with the legislators with whom many of them must have a personal acquaintance, could divert the tendency to outside appropriations to institutions of a similar nature as ours and the old time interest by the State could be revived. I would suggest a committee be appointed with that end in view.

I have one more suggestion to offer in this connection. I believe an effort should be made to induce State officials to attend our fair. I would suggest the erection of a guests' headquarters with a reasonable amount of style, with day time accommodations, such as dining hall, wash room and several other rooms provided with seats, desks, writing materials, etc., with special reference to its being occupied by legislators one or more days during the fair. I think it would soon become a feature as legislators' headquarters and would attract other distinguished guests. The accommodations could be turned over to other guests when not in use by the legislators.

I am advised that an organization exists in the Upper Peninsula to promote interest in the State fair by inducing citizens of that part of the State to exhibit and attend our fair. Geographically considered and with that part of the State rapidly developing there might be an Upper Peninsula fair organized which might detract from ours. I recommend cooperation with the organization referred to and if possible gain advantages for them that would neutralize the disadvantage of the long distance.

I believe in the case of organizations desiring privileges, their petitions should be treated with marked respect and the utmost liberality, consistent with the welfare of this Society, especially in the case of farmers' organizations which are growing rapidly and with which we should have a cordial understanding, one of which, the State Grange, I understand negotiations are due to proceed at once.

I am of the opinion that the transportation problem can be greatly improved, especially if a long time location should be decided upon. I think the principal effort should be made with the passenger department and would suggest that an attempted arrangement be made whereby regular rates decrease as distance increases. The large amount of nearby traffic, whose fares would be only nominal sums, would then help to pay the transportation companies on low fares for long distance traffic. This would thus relieve the hardship of the old rule of half fare rates for long distances. Each mile we reach out trebles the territory contributary to the fair. The probable results of this plan I leave to your judgment.

With the class of recommendations aiming to promote interest in our fairs and attract attendance I would include the encouragement of thoroughbred stock sales. They not only attract buyers and sellers but also a great many who desire to gain a knowledge of the value of such stock and are thereby benefited should they desire to become future purchasers. They also benefit the breeding interests of the State.

A criticism from a leading agricultural paper of the State called my attention to the subject of the election of officers. The assertion was made that the officials were selected by a "ring." The fact remains, gentlemen, that the ballot box has not been stuffed, with an average of forty votes in forty years and with 40,000 people within forty rods of the ballot box. Yet it is in evidence that the members of this committee do have an influence in the filling of vacancies on this committee. I contend that this is as it should be. When a vacancy occurs by death, and it is the duty of this committee to fill that vacancy, is it not of interest to us to select a proper person to fill that vacancy? In case a vacancy is to be filled by election should indifference supplant that interest? I think not, gentlemen. This interest, if used to fill vacancies on this committee with men of honor and ability, men adapted to the needs of this Society and who will use that ability with energy and zeal, it then becomes a privilege and not otherwise.

The subject which I shall now call your attention to is the last and most difficult one on which I have undertaken to offer suggestions and advice. I allude to the moral government which, for a limited time, the management of this Society is held responsible for. Ideas of the advice which might be deemed appropriate on this occasion to guide your action would be as numerous as the multitude that attends our

fair. There is one thing certain, gentlemen, we should maintain as high a standard of morals as the enlightened communities in which we hold our exhibitions. That we could do better would be doubtful. And when we are uncharitably criticised our critics should consider that we have human nature to deal with, and the only portion of that we are responsible for making, as we find it, is that which we possess ourselves.

On motion, the address was referred to the following committee: Messrs. Collier, Fifield and Custard.

A communication was received from the Michigan Oxford Down Breeders' Association, which, on motion, was laid on the table.

The President appointed the following Premium List Committee: Messrs. Young, Butterfield, Hoffman, Rice, Boyden, Waldron and McKay.

The following were appointed for the Committee of Rules: Skeels. Custard and Collier.

Recess was taken to Wednesday evening 7:30 p. m.

Wednesday evening the Committee on Premium List and Rules being in session the committee did not meet until 9:30, when the Premium List Committee made their report.

The committee reported that they would not recommend allowing the same animal to be shown in the Michigan and open class. Many objections being found to this privilege. In the Shorthorn class two divisions were made in yearlings to be called the senior and junior. That the date dividing the age between these divisions shall be January 1 of the year in which the fair is held.

Class 2 and 2A, Devon cattle, were stricken from the list and Polled Durhams put in their place.

The committee recommended in class 12 geldings be stricken out and that all horses in this class must be standard bred and registered if over one year old. Those under one year must have registered sire and dam in order to compete.

In class 16 and 16A Cleveland Bays is stricken out and a class for German standard bred and other coach horses put in its place.

The classes for horses owned in Michigan were stricken out and an increase of 20 per cent in the amount of premiums in the classes open to all was recommended.

The class 21 is divided and separate classes were made for mares and geldings.

In the sheep department the diplomas offered for Champion Ram of any age and ewe of any age in all classes.

No change was recommended in the swine department and none in the poultry department.

A slight revision of farm and garden department was recommended to be submitted by the superintendent and secretary.

In the dairy department two or three additional premiums in domestic products were recommended.

In the art department a few additions in specimens of painting on china was recommended.

In the needlework department it was recommended that the sugges-

tion in the report of the superintendent be adopted and single premiums offered for articles by professional artists and dealers. A revision of the list adding to the amount of premiums to be submitted by the superintendent was recommended.

In the horticultural department it was recommended that the exhibitors of collections of fruit be confined to exhibitors from the State. That a special class be made for collections from outside the State. That single plates be open to all. That in the class for county exhibits that 50 varieties should be required in order to receive the first premium. A few additions were made to canned and pickled fruits and vegetables.

In school exhibit the superintendent was authorized to revise the list increasing the amount offered not to exceed $400.

On motion, the report of Premium List Committee was accepted and adopted.

The Committee on Rules reported as follows:

We recommend that Section 21, Article 12, be amended by striking out provision prohibiting an exhibitor from being given more than one premium in the same class.

Also that September 1st shall be the date for determining the age of live stock shown at the fair. Also that the rule prohibiting an animal to compete for more than one prize in any class be amended so that a horse shown as one of a pair may also be allowed to be shown in the same class single, but not in any other class.

That Section 9 of Article 12 be amended to read as follows:

"All animals shown in this department must have been owned and in the possession of the exhibitor on the first day of June previous to the fair, and in Michigan classes must have been in the possession of the owner in the State of Michigan on June first previous to the fair."

On motion of Mr. Waldron, the report was accepted and adopted.

Adjourned to meet Friday morning, January 15th, at 9:00 a. m.

The committee received an invitation from the Saginaw Board of Trade to visit that city on Thursday as guests of the Board of Trade. The invitation was accepted and the city was visited. The grounds to be offered the Society together with the facilities for transportation were shown the committee and at an informal meeting remarks were made by several of the members of the Board of Trade, setting forth the advantages of Saginaw as a place for permanent location for the fair. On behalf of the committee President Howland thanked the Board of Trade and citizens of Saginaw for the entertainment given them and promised to give full consideration to the claims of Saginaw as a place for holding the fair. Ex-Gov. Rich also made a few remarks complimentary to Saginaw people.

The Executive Committee met Friday morning, January 15th, as per adjournment, with the following members present: E. Howland, C. W. Young, I. H. Butterfield, E. W. Hardy. Frank Maynard, H. R. Dewey, F. E. Skeels, John Marshall, Geo. H. German, Eugene Fifield, L. W. Barnes, W. P. Custard, E. N. Ball, W. E. Boyden, J. E. Rice, C. A. Waldron, John McKay, John A. Hoffman, and M. P. Anderson.

Quorum present.

The Finance Committee reported as follows:

Gentlemen—Your Finance Committee to whom was referred the reports of the Secretary and Treasurer of this Society, would report that we have examined and compared the same and that we find them correct, all of which is respectfully submitted.

JOHN McKAY,
H. R. DEWEY,
G. H. GERMAN.

"We would also further report that we have examined the receipts and contracts both of the Superintendent of Privileges and find the same correct as reported by the superintendent of the department."

On motion of Mr. Fifield, the report was received and placed on file.

Mr. McKay moves as follows: "I move that tickets of all kinds excepting complimentary should be in the Finance Committee's hands in the future and should be kept in their hands and they should report the number of tickets that have been used in the superintendent's department."

Mr. Rice makes the following motion: "In the future badges or orders for badges and orders for tickets of all kinds be left in the hands of the Finance Committee for distribution."

Mr. Fifield recommended keeping track of the badges and buttons given.

Mr. Rice withdrew his motion and the matter was referred to the Business Committee.

The President requested an explanation regarding the advisability of securing a permanent location for the fair. Remarks were made by Messrs. Fifield, Hoffman, Dewey, Young, and Custard.

Mr. Butterfield offered the following resolution:

"Resolved, That it is the sense of the Executive Committee that the State Fair should have a permanent location and to that end we invite proposals to furnish suitable grounds and buildings for holding the annual fairs of this Society."

On adoption of this resolution the yeas and nays were called for and the following members voted yea: Messrs. Collier, Howland, Young, Butterfield, Hardy, Maynard, Dewey, Skeels, Marshall, German, Fifield, Barnes, Custard, Ball, Boyden, Rice, Waldron, McKay, Hoffman, Anderson, and nays none.

Motion was made by Mr. Fifield that a committee of five be appointed by the President to receive proposals from different cities who desire the Society to locate there, until February 15th, to report to the full committee.

Motion was carried.

Mayor Guillott, of Pontiac, appeared before the committee and said he was prepared to present a proposal of Pontiac for the permanent location of the fair, but from the fact that the time for presenting such proposals had been extended by action of the committee he would wait until the proper time for presenting such proposal.

Mr. Maynard asked leave to make a few remarks concerning Jackson as a place for permanent location of the fair and said that a proposal would be presented from that city.

Mr. Hoffman presented an invitation from the medical superintendent

and board of trustees of the asylum at Kalamazoo to meet at the asylum as guests of the board at any time most convenient to the committee.

On motion, the thanks of the committee were tendered the board and the invitation accepted, and the President requested to call a meeting at the asylum at any time when the business of the committee would allow of this being done.

Mr. Anderson of the committee to confer with Mr. Hupp regarding his claim for damages reported as follows:

"We report that we see no claim that would be due this gentleman from the Society and it would be establishing a bad precedent to entertain any damage settlement with him whatever."

On motion of Mr. Fifield, the dates of next year's fair were made from the 12th of September to the 16th inclusive.

The election of the General Superintendent and members of the Business Committee was then taken up, with Mr. Hall and Mr. German as tellers.

On motion of Mr. Skeels, the Secretary was directed to cast a ballot for Mr. Fifield as General Superintendent; Secretary reported the ballot as cast, and the President declared Mr. Fifield elected.

Mr. Anderson moved that the Secretary cast ballot of the committee for Mr. Hoffman as a member of the Business Committee. Ballot so cast and President declared Mr. Hoffman elected.

On motion, the salary of the Secretary was made $1,200 per annum and the salary of the Treasurer was made $400 per annum. The salary of Chairman of Business Committee was made $300 per annum.

The Chairman of the Business Committee called attention to the amount now in the hands of the Treasurer, from which the Society is receiving no interest and asked the committee if any action was desired in relation to the funds of the Society.

After considerable discussion Mr. Anderson offered the following resolution:

"Resolved, That we prefer to leave the responsibility for the safe keeping of the funds of the Society in the hands of the Treasurer, allowing him any interest that may accrue in payment for such responsibility."

Mr. Anderson also moved: "That the bond of the Treasurer be fixed at $20,000, and that it be furnished by a reliable surety company."

The bond of the Secretary was fixed at $1,000 and bond of Superintendent of Privileges and Concessions was fixed at $5,000, the cost to be paid by the Society.

On motion of Mr. Rice, Mr. Grant of the Board of Trade of Saginaw was invited to accompany the committee to Detroit.

Mr. Skeels moved that the Business Committee be authorized to publish a premium list at a net expense of not over $3,000.

Recess taken to 1:30 p. m.

The Committee on the President's address reported as follows:

Mr. President and Gentlemen—I beg leave to say in behalf of the committee that we wish to express our sentiment and the sentiment of this Executive Committee commending the President for his able and broadminded address. It expresses the opinion of the entire committee, that it is in harmony with the beliefs of this organization and that it is progressive in every degree and the action taken at the meet-

ing this morning confirms some of the recommendations made by the Chairman, and we hope that the general principles in this report will be carried out collectively and individually by all members of the State Fair Board.

As regards the following, your committee would suggest or request that we read this paragraph. "I believe our committeemen, representing so many localities of the State, by a determined effort with the legislators with whom many of them must have a personal acquaintance, could divert the tendency to outside appropriations to institutions of a similar nature as ours and the old time interest by the State could be revived. I would suggest a committee be appointed with that end in view."

In harmony with that suggestion your committee deem it eminently proper that the Chairman be instructed by this body to appoint a committee as heretofore, at the proper time, to solicit the proper aid from the State Legislature.

Again the President says in his address: "I am advised that an organization exists in the Upper Peninsula to promote interest in the State Fair by inducing citizens of that part of the State to exhibit and attend our fair. Geographically considered and with that part of the State rapidly developing, there might be an Upper Peninsula fair organized which might detract from ours. I recommend cooperation with the organization referred to and if possible, gain advantages for them that would neutralize the disadvantage of the long distance."

Your committee in that connection suggests that that part be turned over to the Business Committee with instructions to cooperate with the Upper Peninsula Committee.

We would encourage the stock sales. They not only attract buyers and sellers but all who desire to gain knowledge of such stock.

Inasmuch as that subject has been discussed somewhat and it has been petitioned by the Michigan Short Horn Breeders' Association, we believe, and by the Premium Stock Farm, and some others, and inasmuch as part of that matter is under consideration, we recommend that the matter be referred to the Business Committee with power to act.

With these few suggestions and then again appreciating the gratification of this body for the President's able address, we are respectfully yours.

W. W. COLLIER,
EUGENE FIFIELD,
W. P. CUSTARD.

The President was authorized to appoint a committee of seven on legislation.

The President appointed as Committee on Permanent Location with authority to receive proposals for the same, and report to the Executive Committee: the Business Committee, Treasurer and Mr. Collier.

Mr. Hall presented the matter of Frat. or Society Day at the fair, and on motion of Mr. Skeels, the matter was referred to the Business Committee with power to act.

The matter of appointing headquarters for the Grange at the fair was left in the hands of the Business Committee.

Mr. Waldron offered the following resolution, which was adopted:

Whereas, Parke, Davis & Co. having supplied disinfectants and provided for applying the same in the stock barns and closets on the fair grounds during the fair without expense to the Society, and,

Whereas, During this time no disease was reported among the animals on exhibition, the closets at all times being as free from offensive odor as such public places can be made, the stock stables having no disagreeable smell, with the absence of flies. Therefore, be it

Resolved, That the thanks of this Society are due and are hereby tendered to Parke, Davis & Co. for their efficient work in disinfecting the grounds and buildings during the week of the fair of 1903.

On motion, they adjourned to meet at the call of the President.

The committee at 3 o'clock took the electric cars for Detroit as guests of the Detroit United Railway, and in company with a number of citizens of Pontiac and Oakland county and of Detroit, participated in a banquet at the Russel House, and the mayor of Detroit and several others expressed their wish that the Society would permanently locate at Pontiac.

President Howland and Mr. Fifield and Mr. Young of the board were called on for brief speeches and expressed their pleasure at the courtesy extended the committee by the United Railway and citizens of Detroit.

The Committee on Permanent Location met at Detroit, February 2 and formulated a schedule as a basis for securing proposals for grounds and buildings for the permanent location of the fair.

In response to request for proposals offers were received from Saginaw, Pontiac, Jackson, Ypsilanti, Charlotte and Grand Rapids.

The committee having visited the several localities, a meeting of the Executive Committee was called to meet at Kalamazoo, March 24th.

Meeting of the Executive Committee at the Michigan Asylum, Kalamazoo, March 24, 1904.

Called to order by the President at 9 o'clock a. m.

Present: The President, Vice President, Treasurer, Secretary. Members of the Executive Committee: Messrs. Hardy, Maynard, Dewey, Skeels, Jacobs, Collier, Hall, Marshall, German, Fifield, Barnes, Ball, Custard, Boyden, Rice, Waldron, McKay, Hoffman, ex-Presidents Anderson and Rich.

Dr. Edwards, Superintendent of the Asylum, made some remarks welcoming the committee. President Howland thanked the superintendent for the courtesy.

The object of the meeting, as stated by the President, was to consider proposals for furnishing facilities for the permanent location of the state fair.

The Committee on Permanent Location reported the proposals received and recommended that the representatives of the several cities offering sites be given a hearing.

On motion of Mr. Skeels, the report was accepted and the recommendation regarding the hearing of representatives of the several locations was concurred in.

The several proposals, as received by the Committee on Location, were read by the Secretary. Pending the reading it was announced that the Governor of the State was at the Asylum. On motion of Mr. Baldwin, the President and ex-Gov. Rich were appointed a committee to invite the Governor to meet the Executive Committee.

The Governor appeared and made a few remarks.

The reading of proposals was completed. A discussion arising regarding the conveyance of title of lands which may be selected as a location, Mr. Young moved that "no conveyance be accepted which does not convey a title in fee simple." After further discussion, the motion was withdrawn and a recess was taken to one o'clock p. m.

Thursday, March 24th, 1 o'clock p. m.

Called to order by the President. Same members present.

President Mills of the Asylum Board was introduced and welcomed the committee and delegates from cities present. President Howland responded.

The President announced that delegations invited to present proposals would be called in alphabetical order of the cities represented.

Charlotte was represented by Mr. H. S. Maynard and Mr. George A. Perry.

Jackson by Hon. J. C. Sharpe.

Pontiac by Hon. H. C. Guillott and Robert Oakman of the Detroit United Railway.

Saginaw by Gov. Bliss, Mayor Baum and G. W. Weadock.

Ypsilanti by Capt. E. M. Allen, Mr. Ainsworth and John K. Campbell.

A recess was then taken to 7:30 p. m.

The committee met at 7:30 p. m.

Same members present and also Mr. Dean. Mr. Baldwin moved that the committee proceed to ballot for a place for permanent location of the fair. Mr. Skeels moved as a substitute that when the committee adjourns that it be to meet at Lansing, Thursday, April 7th, at 8:00 p. m.

In the discussion that followed, Mr. Hoffman favored closing up at this meeting. Mr. Collier favored definite action. Mr. Rich suggested that a small committee be appointed to secure further propositions from the railroads, abstracts of titles to lands, etc. After further discussion, participated in by Messrs. Skeels, Collier. Waldron, Hoffman, Hardy and Anderson, the substitute was adopted.

Mr. Hardy moved that the President and Mr. Anderson be added to the committee on location.

Carried.

On motion of Mr. Skeels, the committee on location was instructed to secure from the railroad companies agreements in writing for the construction at any grounds selected for permanent location, such

tracks, sidings, platforms and station facilities as in their judgment are needed for the handling of freight and passengers at the fair grounds and report the agreements received to the Executive Committee at the next meeting.

Mr. Custard moved that the locating committee be instructed to ask that a deed be filed and an abstract furnished by the several localities submitting proposals. After discussion, the motion was withdrawn.

Mr. Skeels moved that the question of receiving additions to bids be referred to the locating committee. After discussion, withdrawn.

Mr. Hardy moved that the proposals received by the locating committee on February 20th, be those considered by this committee. Motion withdrawn.

Mr. Skeels moved that the status of proposals for location with regard to time of acceptance be referred to the locating committee.

Carried.

It was moved by Mr. Skeels that the thanks of the Executive Committee are due, and are hereby tendered to the authorities of the Asylum, and to the ladies for entertainment and courtesies extended to the committee at this meeting.

Adopted unanimously by a rising vote.

On motion, adjourned to meet at Hotel Downey at Lansing, Thursday, April 7th at 8 o'clock p. m.

Meeting of the Executive Committee at Lansing, April 7th, 1904, at 8 o'clock p. m.

Called to order by the President.

Present: Messrs. Fifield, Barnes, Custard, Ball, Boyden, Dean, Rice, Waldron, McKay, Hoffman, Hardy, Maynard, Dewey, Skeels, Jacobs, Collier, Hall, Marshall, German, Anderson, Rich, President Howland, Vice President Baldwin, Treasurer Young, and Secretary.

Minutes of last meeting read and approved.

Mr. Anderson made some remarks relating to the object of the meeting. The Committee on Location reported as follows:

To the Executive Committee:

Gentlemen—Your Committee on Permanent Location having considered the subjects referred to the committee at the meeting at Kalamazoo, held March 24th, relative to securing written agreements from steam and electric railway companies, to provide necessary facilities for handling freight and passengers on permanent grounds, would report that there has been received from the Michigan Central Railroad for places named on its line, from the Grand Trunk Railway for Pontiac and from the Pere Marquette for Saginaw, also from the electric railways at the several places, agreements to provide such facilities which, in the judgment of your committee, are sufficient.

Regarding the status of proposals as to time of acceptance, your committee recommend that they be received as they appear at the present time.

Your committee also recommend that representatives of the several cities have fifteen minutes each, in which to further advocate their advantages as permanent locations before the Executive Committee.

EUGENE FIFIELD,
Chairman.

On motion, the report was accepted.

On motion of Mr. Rich, the report was adopted, with an amendment that the time given to hearing be ten minutes for each city.

On motion, Mr. Collier was appointed time-keeper for speakers.

Places were called in the order following:

Charlotte, no response; Jackson, by J. C. Sharpe; Ponitac, by A. L. Moore; Saginaw, by G. W. Weadock, Gov. Bliss, Mayor Baum, Mr. Benjamin; Ypsilanti, by Capt. E. M. Allen, John K. Campbell.

On motion of Mr. Anderson, the committee proceeded to an informal ballot for permanent location, with the following result:

Whole number cast, 25. Jackson, 6; Pontiac, 9; Saginaw, 7; Ypsilanti, 2; Charlotte, 1.

There being a question raised as to the number of votes necessary for a choice, it being stated also that the statute providing for permanent location required a majority of the members of the Executive Committee. It was moved and carried, that a majority of the Executive Committee be required to locate permanently.

Twenty informal ballots were taken without choice, and on motion, a formal ballot was ordered. Thirty-one formal ballots were taken without choice.

Mr. Rich moved that the committee announce that they are unable to agree and ask for the new bids. Carried on aye and nay vote as follows:

Ayes—Barnes, Custard, Rice, Hoffman, Hardy, Jacobs, Collier, Hall. German, Rich. Howland, Baldwin, Young, Butterfield—14.

Nays—Fifield, Ball, Boyden, Dean, Waldron, McKay, Maynard, Dewey. Skeels, Marshall, Anderson—11.

A recess was taken for fifteen minutes.

Mr. Hoffman moved that when the committee adjourn, it be to meet at the Post Tavern, Battle Creek, on Tuesday, April 19th, at 8 o'clock p. m.

Carried.

On motion of Mr. Jacobs, the Secretary was directed to receive sealed bids for permanent location, to be presented to the Executive Committee at its next meeting.

On motion, adjourned.

Meeting of the Executive Committee held at Post Tavern, Battle Creek, Tuesday, April 19th, at 8 o'clock p. m.

Called to order by President Howland.

All members present, except Mr. Palmer.

Mr. Hinds moved that the fair of 1904 be, if held, at Pontiac.

Lost on aye and nay note as follows:

Ayes—Dean, Rice, McKay, Hinds, Jacobs, Collier, Hall, German, Rich, Howland, Baldwin, Butterfield—11.

Nays—Fifield, Barnes, Custard, Ball, Boyden, Waldron, Hoffman, Hardy, Maynard, Dewey, Skeels, Marshall, Anderson, Young—14.

On motion of Mr. Hoffman the bids for permanent location of fair were opened and read.

Saginaw offered 85 acres of land and $27,500, also another site of 85 acres and $30,000.

Pontiac offered additional land to that now occupied by the Oakland County Agricultural Society, making 70½ acres, and all the buildings and improvements now on the grounds.

Ypsilanti offered 80 acres of land and $5,000.

Jackson offered 85 acres of land, known as Cooley Park, with all the improvements thereon and $25,000.

Mr. W. C. Anderson, of the Detroit citizens' committee, presented an offer of a suitable site of not less than 80 acres of land and $35,000.

On motion of Mr. Dewey, twenty minutes was allowed to representatives of each place to present its claims, and the cities were called in alphabetical order.

Mr. Collier was appointed time-keeper. Detroit, Mr. E. M. Hopkins. Jackson, by Mr. Potter and Mr. T. M. Barkworth; Pontiac, by Mayor Riker and D. L. Davis; Saginaw, by G. W. Weadock; Ypsilanti, by Capt. E. M. Allen.

A recess for ten minutes was taken.

On assembling with same members present, on motion, proceeded to formal ballot for place for permanent location of state fair. Mr. Skeels and Mr. Hall appointed tellers.

First ballot.—Pontiac, 6; Jackson, 5; Detroit, 7; Saginaw, 6; blank, 2.

Second ballot.—Pontiac, 5; Jackson, 5; Detroit, 8; Saginaw, 7; blank, 1.

Balloting was continued without result until on the fifty-seventh ballot. Pontiac, 1; Jackson, 2; Detroit, 14; Saginaw, 8.

Detroit having a majority of votes of all members of the Executive Committee, the President declared Detroit as the choice for permanent location of the state fair.

Mr. Skeels moved that the vote be made unanimous, all members vote aye except Mr. Boyden.

Mr. Hoffman moved that the committee meet at Detroit at the call of the President to inspect sites offered. The motion was laid on the table.

Representatives of Detroit were requested to come before the committee for conference regarding inspection of sites.

On motion of Mr. Collier, the committee adjourned to meet at the Griswold House, Detroit, on Friday, May 6th, at 9 o'clock a. m.

Meeting of the Executive Committee at the Griswold House, Friday, May 6, 1904.

Present: President Howland, Messrs. Baldwin, Young, Butterfield, Fifield, Barnes, Custard, Ball, Boyden, Rice, Waldron, McKay, Hoffman, Hinds, Skeels, Jacobs, Collier, Hall, Marshall, German, Anderson, Rich, Dewey.

Minutes of meeting at Battle Creek read and approved.

Mr. Boyden moved that Mr. Collier be requested to confer with the citizens' committee of Detroit and ask a joint meeting.

A recess was taken to 9 o'clock.

On assembling, Mr. Skeels moved that the site known as the Medbury site, located on Woodward avenue, containing 80 acres of land, be the choice of this committee as a location for the state fair, provided that all the conditions as to water, sewerage, light, fire and police protection, and railroad facilities as required by the specifications made by this committee be fulfilled.

Mr. Jacobs moved to amend by accepting the site proposed if the whole front of this tract of land on Woodward avenue be included.

Amendment accepted.

Mr. Rich moved as a substitute, that the site on Grand River avenue, known as the Ferguson tract be accepted.

Substitute not seconded. The amendment was lost.

The motion was carried.

Mr. Baldwin moved that the Business Committee be directed to complete the contract and transfer of land for site and acceptance of the money consideration on behalf of the Society, as mentioned in the proposal.

Carried.

The Business Committee and Mr. Young and Mr. Skeels were directed to visit other state fair grounds in their discretion and to prepare plans of grounds and buildings for improvement of new site, and present to the Executive Committee at a future meeting.

On motion, adjourned.

REPORT OF HOUGHTON COUNTY AGRICULTURAL SOCIETY.

Houghton, Michigan, December 31, 1903.

We, the undersigned, J. H. Jasberg, President; Charles H. Moss, Treasurer, and Ira E. Randall, Secretary, of the Houghton County Agricultural Society, for the year ending December 31st, do hereby certify, sign and submit this, our annual report for the fiscal year ending December 31, 1903.

JOHN H. JASBERG,
President.
CHARLES H. MOSS,
Treasurer.
IRA E. RANDALL,
Secretary.

HOUGHTON COUNTY AGRICULTURAL SOCIETY REPORT FOR THE FISCAL YEAR ENDING DECEMBER 31, 1903.

RECEIPTS AND DISBURSEMENTS.

	Receipts.	Disbursements
Membership fees	$362 00	
Sale of tickets at fair	2,495 10	
Sale of old lumber	100 00	
Privileges at fair	109 44	
Premium checks donated	41 25	
Cash by error	1 00	
Amphidrome building eight days		$200 00
Amphidrome lighting		84 00
Great Northern Quartette		170 00
Great Northern Quartette R. R. tickets		68 60
Quincy band		242 00
Lumber		193 78
Premiums paid		624 50
Printing		197 98
Advertising		263 20
Postage		45 50
Bicycle rider		75 00
Labor at fair		289 52
Material for decorating, etc		93 09
Wiring Amphidrome for lights		87 00
Express		10 00
Commission on sale of tickets		56 75
Stenographer for year		175 00
Incidental expenses		237 70
Over draft	4 83	
Totals	$3,113 62	$3,113 62

MICHIGAN STATE GRANGE.

Report of the Order of Patrons of Husbandry in Michigan for the year ending June 30, 1904.

OFFICERS FOR 1904.

Master—G. B. Horton, Fruit Ridge.
Overseer—N. P. Hull, Dimondale.
Lecturer—Mrs. Frank Saunders, Rockford, R. F. D.
Steward—T. E. Niles, Mancelona.
Assistant Steward—Wm. Robertson, Fremont.
Chaplain—Perry Mayo, Ceresco, R. F. D.
Treasurer—E. A. Strong, Vicksburg.
Secretary—Miss Jennie Buell, Ann Arbor.
Gate Keeper—G. A. Whitbeck, Montague.
Ceres—Mrs. Anna R. J. Wilson, Lapeer.
Flora—Mrs. Virginia Halladay, Clinton.
Pomona—Mrs. Della Proctor, Dansville.
Lady Assistant Steward—Mrs. Mary Robertson, Fremont.

EXECUTIVE COMMITTEE.

F. W. Redfern, Maple Rapids	December,	1905
E. A. Holden, Lansing	"	1905
Emory E. Owen, Lapeer	"	1905
Thos. Mars, Berrien Center	"	1904
A. E. Palmer, Kalkaska	"	1904
M. T. Cole, Palmyra	"	1904
T. H. McNaughton, Ada	"	1904

G. B. Horton, Fruit Ridge,
Jennie Buell, Ann Arbor,
Ex Officio.

During the year the growth and interest in the organizing of farmers for self improvement and betterment of their conditions has gone steadily on. The movement seems to stand on a firmer basis and to be making a healthier advance than in the early days of farmers' orders when they made a mushroom growth good but for a brief time.

There have been 74 new Granges organized, 13 dormant ones reorganized and six county or Pomona Granges formed.

The summer rallies held in August were attended by many thousands of members of the order and reached a large number besides of the farming class not yet enrolled in organized work. These rallies are made the general disseminating points for distributing organization seed. Sociability is cultivated, one's acquaintance with people is widened and friendships are deepened and cemented closer by the leisurely outdoor assembling of many together.

Other means within the order itself are established to be used for the more effective training of members in progressive methods of Grange work, and in imparting information and giving encouragement to discussions of vital subjects. Among these latter means the improved county Granges of the present time rank first.

One of the most popular questions in Grange meetings of every degree has been that of primary reform. More resolutions came before the State body favoring such a measure than upon all other questions combined.

The State lecture work has been continued with the end in view of unifying programs throughout the Granges. The broad general topics assigned by the lecturer of the National Grange have been incorporated, one a month, into the programs suggested by the State lecturer. Into the alternate program an agricultural topic has been introduced. For the better study of the farm subjects, special bulletins have been prepared by members of the Agricultural College faculty and sent out by the State lecturer. These have met with great favor and have improved the character of the real educational work done through the Grange. Everywhere it is observed that more intelligent lecture hour work is being carried into the programs of the local and county Granges. Each session of State Grange undertakes to encourage the thought that the lecturer is a teacher and therefore needs something akin to normal training in Grange methods and in ways of teaching agriculture. In addition to the usual lecturers' conference, last December, there were given several addresses on Grange and agricultural education which proved very valuable along this line.

The increasing membership and number of Granges have called for an extension of supervision of the local work and a corps of special deputies, accountable to one general deputy, has accordingly been appointed. This is tending to strengthen and unite all the work and interest.

Another new department is known as the bureau of information. This aims to bring buyers and sellers into more direct contact through the advertising medium of the Grange information bulletin and is proving quite satisfactory.

The former plan of State Grange making contracts with wholesale houses is maintained with increasing patronage. The Grange now has a farm fence agency covering the State and its binder twine sales now approximate 450 tons.

Slowly, but surely, we trust this body of Patrons of Husbandry banded together for self culture and the uplift of those in similar environment, is raising the standards of work and living outside and inside the farm homes of Michigan.

JENNIE BUELL,
Secretary.

REPORT OF THE MICHIGAN STATE ASSOCIATION OF FARMERS' CLUBS.

Officers of the State Association of Farmers' Clubs, 1903-1904:

President—Hon. N. A. Clapp, South Lyon.
Vice President—Mrs. G. E. Brown, Mt. Pleasant.
Secretary—Mrs. George Auten, Clyde.
Treasurer—Mrs. Charles Cook, Owosso.

DIRECTORS.

L. C. Baker, Wolf Creek, term expires 1904.
Capt. W. M. Horton, Fowlerville, term expires 1904.
A. L. Chandler, Corunna, term expires, 1905.
E. H. Richey, Vassar, R. F. D. No. 3, term expires 1905.
Charles B. Cook, Owosso, term expires 1906.
Z. W. Carter, Lake Odessa, term expires, 1906.

Since the last report was made Lansing has again entertained in our beautiful capitol the State Association of Farmers' Clubs. December 8-9, 1903, the Senate Chamber was filled with enthusiastic ladies and gentlemen, co-workers in this grand and noble farmer club movement. There were representatives from the north, south, east and west of our beloved Michigan.

When I accepted the office of Secretary of the Michigan State Association of Farmers' Clubs, and examined the records, lists of clubs, etc., it became evident to me that a new system of work and a revised and corrected roll of membership was necessary. The only memoranda on file in the secretaries book was the name of the clubs and the address of the secretaries. Information in regard to the date of organization, changes in membership and officers, and present condition of clubs were conspicuous by virtue of their absence. It reminded one of a country utility store without an invoice, and such an invoice was determined upon. In pursuance of the plan adopted, this blank was mailed to the secretary of every club as given in the official roll.

MICHIGAN STATE ASSOCIATION OF FARMERS' CLUBS.

Secretary's Office, Clyde, Michigan.

To the Secretary:

The State Association of Farmers' Clubs would like to have the following questions answered in order to have on file a correct and accurate report of all clubs organized.

It is therefore earnestly requested that you fill out the enclosed blank and return as soon as possible to the office of the Secretary of the State Association.

Name of Club..
County..
President.............................. P. O....................
Vice President......................... P. O....................
Secretary.............................. P. O....................
Corresponding Secretary................ P. O....................
When Organized..
Number of Members...

If there are any clubs recently organized in your vicinity, kindly send us the name of a member or officer so that we may write them for full report.

Do not delay but please attend to it at once, and oblige,

MRS. GEO. H. AUTEN,
Secretary of State Association.

A notice was also inserted in the Michigan Farmer, requesting the secretary of newly organized clubs to report the same to the State Secretary. The following is a brief report of the results up to date:

Clubs in good standing and in thriving condition	127
Clubs that have never been recorded	14
Clubs disbanded	11
Clubs not heard from to date	50
Total number of members reported	8,750

From these figures it is evident that the rural communities of Michigan are truly in earnest in their endeavor to promote the welfare of their brother workers and incidentally their own surroundings and conditions, but earnest efforts properly guided and applied will accomplish infinitely more than those efforts, however earnest, which are allowed to act at random. The steady, regular blows of the hammer upon the drill, turned by the experienced miner penetrates the hardest rock.

Likewise systematized and unified efforts will unite us closer together and expand our field of operations.

At the next convention I shall propose that a by-law be passed requir-

ing the local secretaries to report yearly to the State Secretary. This report to incorporate the following: Number of meetings held during the year; average attendance; whether or not associational questions are discussed; number of old and new members, and the names and addresses of the officers, also that printed sheets be furnished the clubs by the association for this purpose.

I should like to call the attention of the club members to a plan for increasing our membership, in which judicious notices are to be inserted in the small local papers, advocating an organization of farmers, and asking anyone so interested to correspond with the Secretary of the State Association.

Upon which the Secretary is to notify the organized club nearest the locality sending this request, to appoint one of their members to meet with and assist in organizing the petitioning club. In this way the opportunity of attending a farmers' club will be in reach of all. So let us never grow weary in well doing, for we know we will then succeed if we do our work cheerfully and well.

MRS. GEO. AUTEN,
Secretary.

FRANKLIN WELLS.

The pioneers of Michigan, those who founded and builded the State and its institutions, merit the admiration of its citizens of a later day. No praise can be too lavish for the men and women who came to this State, and cleared its farms, builded its towns, founded its churches and schools, its larger institutions of learning, and established its system of laws. They were people largely from New York and New England, descendants of the fathers and mothers of the Revolution, and brought with them to Michigan the patriotism, the recognition of the moral force exerted by the church, an appreciation of the value of an education, and a knowledge of the importance of a just system of laws, that belonged to the fathers of the republic.

Mr. Wells coming to the State as a youth, soon after its admission to the Union, was able to take part in this work of State building, and gave more than sixty years of an active life to that end.

Franklin Wells was born in Salem, New York, April 19, 1823. His father was Joseph Wells who came to New York from Connecticut. His mother was Lucy Hollister. Joseph Wells was a very religious man and brought up his family in accordance with these views. Franklin's early education was obtained in the primary schools, with a few terms in the Washington Academy at Salem. In 1837 his father came to Michigan, making the journey by wagon, and arriving at the farm selected at Mottville, St. Joseph county, June 12th of that year.

In 1838 Franklin, then 15 years of age, went to Constantine as clerk in the store of Albert Andrus & Co. Two years later he was employed by John S. Barry, afterward Governor of the State. He was also employed in the store of Joseph R. Williams, who was afterward the first president of the Agricultural College. In 1842 and before he was of age he entered into partnership with his former employer Albert Andrus, which continued for four years, when he bought out Mr. Andrus and continued a general mercantile business, wool buying, etc., until 1871.

In 1861 he purchased a farm of 300 acres near Constantine and a little later another of the same size in Florence township. These farms he improved and cultivated to the time of his death. He was a lover of good farm stock and established a herd of short horn cattle.

Mr. Wells was always prominent in local public affairs. He was, in his early days, township clerk, later president of the village of Constantine, for more than a quarter of a century a member of the village school board, and for ten years its president. He was postmaster at Constantine from 1869 to 1873 and again from 1882 to 1886. From 1878 to 1890 he was county agent of the State Board of Corrections and Charities. He served one term as statistical agent for Michigan of the United States Department of Agriculture.

He was an ardent republican and took active part in political affairs, having been at different times chairman of the county committee. He enjoyed the personal acquaintance of Gov. Bagley, Senator Chandler, Senators Stockbridge and Burrows, and could have held prominent of-

fices in the State, but he steadfastly declined any proposals for nomination for such offices.

In 1873 he was appointed by Gov. Bagley, member of the State Board of Agriculture, and it was on this board that his most important public work was given. For thirty years he devoted his best efforts to the advancement of the interests of the Michigan State Agricultural College.

His appointment on the board came at a time when the college was making its hardest struggle for existence. It had just escaped amalgamation with the university. There had been for a year or two previous considerable friction in internal management. The resources of the college were small and there was no great prospect of improvement. Gov. Bagley fortunately had a full appreciation of the value of the State educational institutions. In his first message he advocated liberal appropriations to the university and the college. The total State appropriation for 1873 was $27,316, and the interest from the land grant fund was $11,038.48. The total college expenditures for the year including boarding hall was $50,535.39.

Mr. Wells accepted the office in the same spirit which characterized all his work. He made the college business his business. In those days it was customary for the board to be met by the college team on arrival at the station, whence they were taken to the home of the president or a member of the faculty, to be entertained during their meeting. Hotel bills were almost unknown in the board members accounts of those days.

Gov. Bagley's recommendation of liberality to the educational institutions bore fruit, and the legislative appropriations were larger and more freely given than for some years previous. From this time on the college continued slowly to gain the support of the farmers of the State, a support which should have been expected from the start, but which was not always given.

Mr. Wells' committee work on the board during his first term was on the finance and farm committees. On the former his business training made his services exceedingly valuable. He always strove to maintain the college along the original ideas which its founders had proclaimed at the beginning. While neglecting no other valuable feature he always sustained every movement to improve its agricultural department.

In 1883 on the death of Hezekiah G. Wells, who had been president of the board for many years, Mr. Franklin Wells was elected president and was re-elected at each biennial reorganization till 1899. He was again elected in January, 1903. He thus served on the board a few months over thirty years, and as its president sixteen years.

A material monument to his memory, which will last for many years is the double row of elm trees growing along the north side of the campus and orchard, planted at the suggestion of Mr. Wells.

The details of Mr. Well's valuable work for the college are not contained in the records of the Board of Agriculture. They cannot be written. They are etched upon the map of the campus in living characters, and stand out in relief in its architectural monuments. More permanent even than this, is the impress he made upon his fellow members of the board, the faculty of the college, the alumni and students, all who were his contemporaries during those thirty years, and from them to be transmitted to successors and to successive generations.

Mr. Wells early in his career gained the confidence and respect of the people of his own home town and of St. Joseph county. So sound was his judgment and so perfect his integrity that his neighbors of all classes came to him for advice and help, and they never were repulsed. How much of his time was taken in this kind of work will never be known, but it was not forgotten and the whole community mourned his death.

Mr. Wells' strongest characteristic, as it appeared to me, was his devotion to duty and to principle. Whatever he decided to be his duty became his ruling passion, and he could not be swerved from it. He was a man of strong sympathies. He loved his family, he was true to his friends. A daughter writes, that to her his strongest point was courage. This does not conflict with my estimate, because devotion to principle requires much courage. He was a very kind hearted man, his children loved him, as he loved them. He believed in the golden rule and practiced it.

Nothing better can be said of any man.

I. H. BUTTERFIELD.

INDEX.

INDEX.

A.

B.

C.